VOLUME LXI NUMBER 6 WHOLE 539

SCHOOL SCIENCE AND MATHEMATICS

JUNE 1961

School Science and Mathematics

A Journal for All Science and Mathematics Teachers

All matter for publication, including books for review, should be addressed to the editor. Payments and all matter relating to subscriptions, change of address, etc. should be sent to the business manager.

Second-class postage paid at Menasha, Wisconsin and at additional mailing offices. Published Monthly except July, August and September at Curtis Reed Plaza, Menasha, Wis. PRICE: Six dollars a year; foreign countries $6.50; current single copies 75 cents.

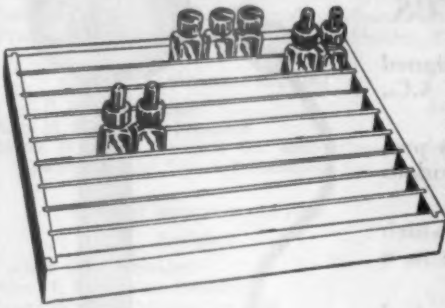
Contents of previous issues may be found in the Educational Index to Periodicals.

Printed in the United States of America

CONTENTS FOR JUNE, 1961


CANCER
LEO
GEMINI
VIRGO
TAURUS
ARIES
LIBRA
PISCES
AQUARIUS
CAPRICORNUS
FEBRUARY
JANUARY
MARCH
DECEMBER
APRIL
NOVEMBER
MAY
OCTOBER
SEPTEMBER
AUGUST
JULY
CLOCK FAST
CLOCK SLOW
CLOCK SLOW
CLOCK FAST
SOLSTITIAL
EQUINOCTIAL

WACO SEMI-MICRO APPARATUS



Wilkens-Anderson has earned its place as specialist in Apparatus for Semi-Micro chemistry . . . through the years authors have looked to us for the pieces which made their Semi-Micro text books and manuals so successful and easy to use! Seven text books now show WACO S-M apparatus!

WEISBRUCH-WACO Reagent Bottle Tray

According to SEMI-MICRO LABORATORY EXERCISES In High School Chemistry, by Fred T. Weisbruch.

Holds complete set of student reagents in WACO Reagent Bottles, in rows. Made of hard maple and birch, a permanent piece used many years. Size 12 x 10½ x 1¼ inches. Without bottles, $3.25 each . . . in dozen lots $2.95 each. Specify Cat. No. S-10490-1.

HAND FINISHED SPATULAS

Perfectly shaped spatulas for Semi Micro Qualitative and Organic Chemistry. W A C O Monel Spatulas are nicely balanced, permanent pieces. Glassware breakage is reduced, as scratching is eliminated. No. S-10115 WACO Monel Spatulas 175 mm. long. Slightly dished tip to hold crystals. $3.10 per doz., $24.00 per 100.

At the price, W A C O Spatulas class as "Non-Returnables!"

Write today for FREE brochures . . .

- Complete Catalogue WACO Semimicro Apparatus, Vol. S-1.
- Listing of S-M Apparatus according to SEMI-MICRO LABORATORY EXERCISES In High School Chemistry, Fred T. Weisbruch.

LABORATORY SUPPLIES AND CHEMICALS

WILKENS-ANDERSON CO.

4525 W. DIVISION ST., CHICAGO 51, ILLINOIS

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS—OFFICERS FOR 1961

President—Cecil B. Read, University of Wichita, Wichita, Kansas
Vice-President—Alice M. Hach, Ann Arbor Public Schools, Ann Arbor, Michigan
Secretary-Historian—Joe Kennedy, Indiana State Teachers College, Terre Haute, Indiana
Treasurer-Business Manager—Luther Shetler, P.O. Box 108, Bluffton, Ohio

EXECUTIVE COMMITTEE FOR 1961

Cecil B. Read, President
Alice M. Hach, Vice-President
James H. Otto, President for 1960, George Washington High School, Indianapolis, Ind.

BOARD OF DIRECTORS FOR 1961

Ex-Officio

Cecil B. Read, President
Alice M. Hach, Vice-President
James H. Otto, President for 1960

Terms Expire in 1961

Lawrence A. Conrey, University High School, Ann Arbor, Michigan
David Laird, Washington Township High School, Centerville, Ohio
R. Warren Woline, Oak Park-River Forest School, Oak Park, Illinois
Aubrey G. Wood, Memorial High School, Beloit, Wisconsin

Terms Expire in 1962

William A. Hill, Naperville High School, Naperville, Illinois
Donovan Johnson, University of Minnesota, Minneapolis, Minnesota
Sister Mary Ambrosia, Holy Redeemer High School, Detroit, Michigan
Glen D. Vannatta, Broad Ripple High School, Indianapolis, Indiana

Terms Expire in 1963

Carl W. Clader, New Trier Township High School, Winnetka, Illinois
M. Wiles Keller, Purdue University, Lafayette, Indiana
T. Reginald Porter, State University of Iowa, Iowa City, Iowa
Joseph J. Urbancek, Chicago Teachers College, Chicago, Illinois

JOURNAL OFFICERS

George G. Mallinson, Editor, 535 Kendall, Kalamazoo, Michigan
Jacqueline Mallinson, Assistant Editor, Kalamazoo, Michigan

SECTION OFFICERS FOR 1961

(Order: Chairman, Vice-Chairman, Secretary)

Biology and Conservation

Robert C. Wallace, Reavis High School, Oak Lawn, Illinois
Louis E. Shrode, Oak Park-River Forest High School, Oak Park, Illinois
Byron G. Bernard, LaPorte High School, LaPorte, Indiana

Chemistry

Carl J. Engels, Western Michigan University High School, Kalamazoo, Michigan
Virgil H. Heniser, Howe High School, Indianapolis, Indiana
Eugene Herbener, Trenton High School, Trenton, Michigan

Elementary Mathematics

Joseph N. Payne, University of Michigan, Ann Arbor, Michigan
Joseph J. Stipanowich, Western Illinois University, Macomb, Illinois
David W. Wells, Oakland County Schools, Pontiac, Michigan

Elementary Science

Barbara Wehr, Laboratory School, University of Chicago, Chicago, Illinois
Virginia Tileston, School 68, Indianapolis, Indiana
Joseph Lucci, Mettatal Junior High School, Detroit, Michigan

General Science

David Schulert, Lansing Public Schools, Lansing, Michigan
Sister Mary Imelda, St. Cyril High School, Detroit, Michigan
Thomas Given, Brownell Junior High School, Grosse Pointe, Michigan

Mathematics

Thomas Schneider, Cody High School, Detroit Michigan
Ralph Smith, Oak Park-River Forest High School, Oak Park, Illinois
Edith Benjamin, Arlington Heights High School, Arlington Heights, Illinois

Physics

Richard F. Olufs, Grayslake High School, Grayslake, Illinois
Jerry M. Colglazier, Franklin Central High School, Acton, Indiana
Bert S. Buscher, DeKalb High School, DeKalb, Illinois

SCHOOL SCIENCE AND MATHEMATICS

Vol. LXI | June, 1961 | Whole No. 539

A Demonstration Exercise in Observation and Deduction*

C. N. Goeders

Iowa Falls High School, Iowa Falls, Iowa

Experienced workers in chemical education know that effective presentation of chemical topics to young and unsophisticated audiences demands varied techniques to hold attention and focus young minds on the subject matter. A high school teacher who lectures interminably may be remembered by his students as an authority but not as a skillful teacher. The qualities of good lecturing are discussed in J. Barzun's, *Teacher in America*. (1) It is not likely that the percentage of teachers now lecturing in chemistry who possess the qualities of both actor and chemist exceeds a few per cent.

Recognizing these problems and realities, chemical educators have always utilized chemical demonstrations to provide relief from ordinary classroom activity and to present topics not taught as effectively in other ways.

One way in which the chemical demonstration is not commonly employed is as a teaching-test vehicle. This is rather surprising because most demonstrations are performed in an atmosphere of expectation and close attention. What better moment to teach and test! All of the most desirable facets of student, instructor and subject are present. This paper presents a test in observation and deduction to be delivered as a demonstration. This particular demonstration has been used with high school juniors and junior college freshmen with noteworthy results. It takes advantage of optimum teaching conditions to press home that principle basic to all experimental

* Presented at the winter meeting of the Iowa Science Teachers Association, January 24, 1960, at Iowa State University, Ames, Iowa.

science: the observation of phenomena and interpretation of those observations.

The demonstration (2, 3) is used in high school and in the junior college soon after the study of nitrogen and its compounds. The experiment is to generate ammonia under controlled conditions, with the apparatus specified.

First, the instructor announces that this demonstration is to be a test in observation and deduction. Students are to watch carefully and record faithfully. The instructor informs the students to record the sequence in which chemicals are added and to prepare to record their observations. The instructor then performs the demonstration described below. He is not to discuss the physical and chemical changes. Assemble apparatus as in figure 1.

Into a 250 ml. Erlenmeyer flask place fifteen grams (15 grams) of ammonium chloride (NH_4Cl) followed by seven and a half grams

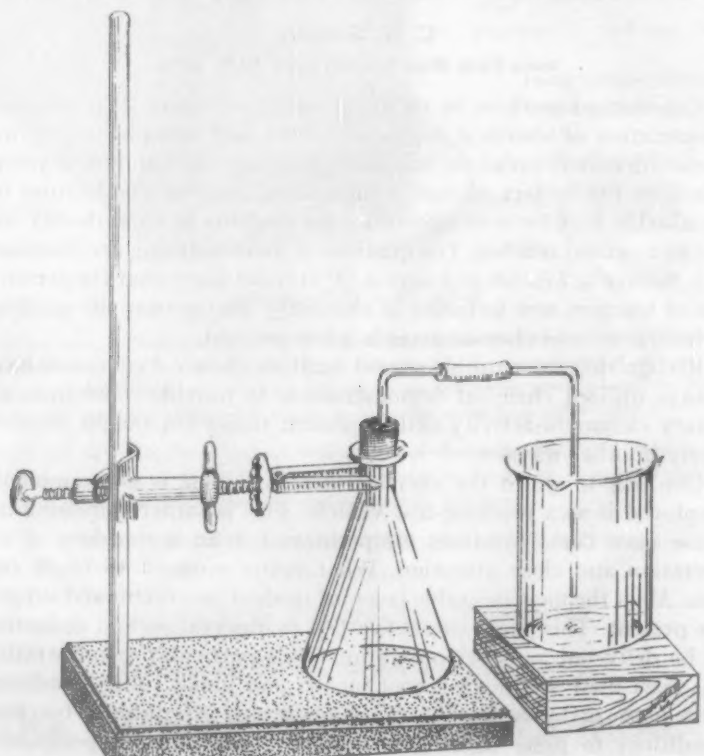


FIG. 1

(7.5 grams) of sodium hydroxide (NaOH) pellets. To this add 10 ml. of water, insert the stopper holding the delivery tube, and agitate. The delivery line has a rubber joint (to provide for movement which makes the experiment more dramatic) at a point roughly half way between the flask and the beaker into which it leads. The beaker contains a few drops of phenolphthalein in water.

Direct the students to hand in a list of their observations with a matching explanation of what happened. Typical results are these:

Observation	*Explanation*
1. Instructor mixed ammonium salt, base, and water. A gas was evolved.	1. The gas is ammonia, since the addition of any strong base to an ammonium salt gives: $NH_4^+ + OH^- \rightarrow NH_3\uparrow + H_2O$.
2. The gas bubbles through the water in the beaker, turning it red.	2. Phenolphthalein which had been added turns pink in basic solution; therefore; the gas must make the solution basic: $NH_3 + H_2O \rightarrow NH_4^+ + OH^-$
3. The bubbles gradually diminish and the solution from the beaker is drawn back into the flask.	3. Since ammonia is very soluble in water (700 to 1), the water from the beaker is drawn into the flask when the rate of evolution $<$ the rate of solution.
4. The total solution in the flask turns pink.	4. Phenolphthalein is pink in base.

As expected, the success of the students with this demonstration-test varies with grade level. It is felt, however, that the primary value of the exercise is the attention focused on "observation and deduction." In teaching the utility and importance of observation and deduction, the teaching-test vehicle described above is regarded as one of our best techniques.

ACKNOWLEDGMENT: The author wishes to gratefully acknowledge the prized aid of his colleagues: Lewis Anderson for preparation of the drawing and J. Dahl and J. Nydegger for criticism of the text.

(1) J. Barzun, "Teacher in America," Little, Brown and Co., Boston, 1947, Chapter 3.
(2) H. Alyea, "Tested Demonstrations in General Chemistry," #17-3 "A.C.S." 1955-56.
(3) R. Barret, "Chem Ed. Tested Demonstration," *Journal of Chemical Education*, 36 10 A619, Oct., 1959.

NEAREST STAR CLUSTER'S MASS 500 TIMES SUN'S

The nearest of all star clusters, the Hyades in the constellation Taurus, the bull, has a mass about 500 times that of the sun. The cluster, which includes the bright reddish star Aldebaran, is at a distance of 130 light years, one light year being six million million miles.

The Hyades cluster, a group of a dozen naked-eye stars, is actually a loose organization containing at least 150 individual members. Their association in a gravitational system has been revealed by their observed similar motions, across the sky as well as in the line of sight.

Elementary School Science and Mathematics Education in Western Europe*

Margaret J. McKibben
U. S. Office of Education, Washington, D. C.

Introduction

A comprehensive comparative study of elementary science and mathematics education in Western European countries and the United States would be of value on both sides of the Atlantic. There is probably much that we could learn from European educators, and much "know-how" which they could gain from us. Such a study should include information on time allotments, course content, methods of teaching, facilities and equipment, and teacher training standards for science courses. It should probably be based on conferences with teachers and other educators and visits to schools, as well as on statistics and syllabuses.

This paper is an attempt to draw together scattered information on science and mathematics education in primary schools (elementary schools, in the United States) in eight selected Western European countries. Specifically, it will outline (1) the subject matter content and (2) the time allotments for primary school science and mathematics courses in Great Britain, the Federal Republic of Germany, the Netherlands, three Scandinavian countries, Switzerland and France.

Learning how to develop and handle concepts of mathematics may help a child in developing some of the more abstract science concepts. If this assumption is correct, the amount and type of study in mathematics is of importance to education in the sciences—especially the physical sciences. It may help to account for the "fast start" in the sciences secondary school students in some European countries are able to make.

The amount of time spent in either science or mathematics is not, in itself, an index of the quality of the program. A program which devotes a large number of hours a week to science, but lacks well-trained and interested teachers or appropriate teaching materials, is still a poor program. Certainly, small differences in time allotment are not significant. But, other things being equal, extremes in the time element are indicative of the stress on a subject in an elementary school curriculum.

Data on time allotments for European elementary school science and mathematics programs would have little significance for American educators without similar figures for the United States. There-

* This is the fifth, and last, in a series of papers written for the AAAS Feasibility Study (April, 1961 issue).

fore, although the main purpose of this paper is to bring together information on elementary science education in Western European countries, similar data on science and mathematics in the United States will be included for purposes of comparison.

Twenty American science and/or mathematics supervisors were asked to provide information about the amount of time required for science and mathematics instruction in their systems. Twelve replied. The geographical distribution was as follows: two, west coast; one, Rocky Mountain; three, middle west; three, north central; and three, south east. Three state, three county, and six city systems were represented. The science and mathematics time allotments in the twelve systems thus secured is shown in Table I.

TABLE I. SCIENCE AND MATHEMATICS TIME ALLOTMENTS IN AMERICAN ELEMENTARY PROGRAMS

School	Grades											
	1		2		3		4		5		6	
	S	M	S	M	S	M	S	M	S	M	S	M
A	1½	3	1½	3	1½	3½	1½	3½	1½	4	1½	4
B	2½*	3	2½*	3	2½*	3	5½*	4	5½*	4	5½*	4
C	1½	3½	1½	3½	1½	4	3	4	3	4	3	4
D	1	2½	1	2½	2½*	3	3½*	5	3½*	5	2*	4
E	1	2	1	2	2	3	2	4	2	4	2	4
F	1*	1*	1*	2	1	4	2	4	3	5	3	4
G	2	2	2	2½	2	3	2½	3	2½	3	2½	3
H	1½	2½	1½	2½	1½	2½	1½	2½	1½	2½	1½	2½
I	1	1	1	1½	2	2½	3	3½	3	3½	3	3½
J	2½	2½	2½	2½	3	2½	3‡	4	3	4	3½‡	4
K	½	2	½	2	½	4	1	4	1½	4	1½	4
L	1½*	½	1–1½*	½	1–1½*	½	1–1½*	1	1–1½*	1	1–1½*	1
Average	1½	2	1½	2	2	3	2½	3½	3	4	2½	3½

* Part of social studies program.
‡ Includes T.V. viewing.
(Throughout the paper time references are in terms of hours per week unless otherwise noted.)

In some American systems, elementary science is part of the social studies program. How great a part was not always indicated by the schools reporting. In such cases it was necessary to estimate the number of hours per week for science. The average amounts of time devoted to science and mathematics in each grade in these twelve systems (last line of Table I) are figures which may be useful in considering time allotments in Western European primary school programs.

The present brief analysis of science and mathematics education in Western Europe is based on a survey of the limited published materials. Data on Great Britain, the Netherlands, Switzerland, and the United States are not well-defined since there is no strong central control of education in these countries, most of the authority lying with the local education unit.

In most of the other Western European countries, a national curriculum exists, although it is often modified extensively to meet regional needs. It would not be practical, because of limitations of space, to include all of the Western European countries in the present paper. In several cases, the educational systems of two countries may resemble each other and little would be gained by considering both. Nor, since data on a number of them was not available, would it be possible—one or two countries evidently do not attempt to teach science at the elementary level. This paper will, therefore, be limited to the elementary school science and mathematics programs of Great Britain, the Federal Republic of Germany, the Netherlands, three Scandinavian countries, Switzerland, and France.

Great Britain

Great Britain has no strong central control of education. Her Majesty's inspectors in science and other subjects exercise a certain amount of authority as to minimum standards of public education. How these standards are maintained is largely up to the head teacher (headmaster or headmistress, as the case may be).

There is great diversity among British secondary schools—even among those which are completely tax-supported. One type prepares for university entrance (grammar school), while the secondary modern school has a general program for those who will not continue their studies. Others, like the American high school, have two or more curriculums, one of which may be university preparatory, another technical, and another general. In addition, there are a number of secondary trade schools.

A search of a number of sources does not reveal anything specific as to the amount of time and type of content for science in British primary schools. A volume outlining practices for teaching science in tropical countries might be considered to reflect practices "back home" in England.[1] It emphasizes practical (laboratory) work with suitable materials, field trips, developing powers of observation, and record-keeping—including drawing.

This book recommends science topics for the six primary school years. The first year would cover trees and other plants, seed and flower collections, animals which are pets, health, the moon and stars, and the sun and shadows. The second year includes many of the same topics, studied in a little greater depth—growth of seeds and cuttings, foods provided by plants, plant-eating animals, seasonal preparations of animals, health, and the composition of the earth.

[1] Joseph, E. D. "The Teaching of Science in Tropical Primary Schools." Oxford University Press, London. 1953.

The following topics are suggested for the third year—identification of leaves, needs of plants and animals, protective devices of plants and animals, health, movements of the earth and moon, air and oxygen, solutions, erosion, and the states of matter.

In the fourth year, the study of plants and animals is differentiated for rural and urban schools. Both types of schools, however, study soil fertility, decay, water purification, infectious diseases, first aid, the thermometer, machines, and sources of power at this level.

Human physiology, photosynthesis, animal parasites, the seasons, the earth's crust, oxidation, dangers due to fire, and conduction of heat are fifth-year topics. The sixth year includes community health, nutrition, sex education, first aid, the solar system, eclipses, weather, light, sound, and an advanced study of machines.

The objectives and content of primary science education recommended here for tropical countries do not differ widely from those found in many American schools.

It is the intention of those in charge of education in Great Britain to educate each child "according to his age, ability, and aptitude." Entrance to a grammar school program is normally based on the results of objective tests taken at the age of eleven at the end of primary education. The "eleven plus examinations," as these tests developed by local authorities are called, contain items designed to measure intelligence, special abilities, and knowledge. Since these examinations vary from one part of Great Britain to another, so would the primary school programs which prepare for them.

Jacobson noted considerable variation in quality in primary science education in Great Britain. "In some British primary schools, children have excellent opportunities for experience in science. There is considerable emphasis on project work by individuals and small groups. Children use materials from the home and community to make equipment and apparatus. For example, a small group of boys made their own telescope and used it to make a very fine map of the moon. From this they were moving on to try to find a relationship between the phases of the moon and the height of the tides in the local harbor. I was impressed by the children's reports of their studies and with the ability of the teachers to work with large classes of children having a wide range of abilities as well as with individuals and small groups. In other British primary schools there are no science programs. However, all science educators and almost all general elementary educators that were queried stated that primary school science was an important area that should be developed in the immediate future."[2]

[2] Jacobson, Willard J. "Lessons from Britain," a paper given at the Eastern Regional Meeting of the Association for the Education of Teachers in Science, Teachers College, Columbia University. October 27, 1960.

A publication for teachers in British primary schools[3] stresses the importance of active exploration of science problems as well as the gathering of facts, a study of physical science in addition to nature study topics, and the use of both practical and field work.

A survey by Hurd[4] indicates that some science in the form of nature study is taught in the primary grades in Scotland, and that in the lower grades, at least, it usually takes the form of a study of the local flora, fauna, and geography. Time allotted is small, increasing to only about an hour per week in the upper grades. The emphasis includes improving powers of observation, understanding natural phenomena, and developing an appreciation of beauty and a humane attitude toward animals.

Conversations of the writer with American and British exchange teachers and with other persons with a British primary school education confirm Hurd's observations that a nature study emphasis lingers in many primary school programs in Great Britain, as well as in Scotland.

It is unfortunate that figures for the number of hours per week spent in arithmetic in primary schools in Great Britain are not available as they are for other Western European countries. Table II, however, indicates the general level of grade placement of topics in arithmetic programs in a number of European countries and in the United States. This table will be referred to repeatedly in later sections of the paper.

Schutter's information is based on an analysis of arithmetic textbooks used in twenty European countries. He found that European schools introduce arithmetic and geometrical concepts early, that children are expected to do a great deal of mental arithmetic, and that arithmetic programs are rigorous. The chart indicates that arithmetic programs in England are somewhat more advanced than those in the United States.

German Federal Republic

The laws of the Federal Republic of Germany, which came into force in 1949, place the whole school system under the supervision of the state. The elementary school (*volksschule*) has eight or nine grades. The first four grades, called the *grundschule*, provide the fundamentals of reading, writing, arithmetic, and local history and geography. Science is not taught at this level, except incidentally.

An examination is given at the end of the *grundschule* period.

---

[3] Allen, G. E. and others. "Science in the Primary School," John Murray Ltd. 1959.

[4] Hurd, Paul DeH. "The Teaching of Biology in Selected European Elementary and Secondary Schools." Biological Sciences Curriculum Study, Boulder, Colorado. 1959. p. 6 and 45.

TABLE II. GRADE PLACEMENT OF ARITHMETIC TOPICS IN THE UNITED STATES AND SELECTED EUROPEAN COUNTRIES*

Topic	Grade of Year of Introduction					
	England	Germany	Holland	Sweden	France	United States
Multiplication & division tables up to the 10's.	3	2	2	2	2	4
Multiplication with carrying, 1-digit multipliers, like 346×4.	3	3	3	3	2	3A–4B
Multiplication with 2-digit multipliers, like 347×54.	3	4	4	4	3	4A–5B
Addition with carrying and subtraction with borrowing.	3	3	3	4	2	3A–4B
Division by 1-digit numbers, with carrying, like 6)492	3	3	3	3	3	4
Division by 2- or 3-digit numbers.	3	4	4	4	3	5
Common fractions: Adding & subtracting with the same denominators;	3	3	4	5	5	5
Adding & subtracting with prime denominators; e.g. with 3rds and 5ths.	5	6	5	6	6	5–6
Multiplication and division of integers by fractions, like $6\times\frac{2}{3}$, $8\div\frac{1}{2}$.	5	5	5	5	5	6
Decimals: Multiplying integers by decimals, like 8×0.63.	6	4	5	5	4	6
Multiplying & dividing decimals by decimals: e.g. 6/3×0.7; 6.24÷0.36.	6	6	6	6	4	6
Percentage.	6	6	6	6	5	7

* Adapted from Schutter, Charles H. "Some Features Important in European Arithmetic Programs." *The Arithmetic Teacher*, 7: 6. January 1960.

Results of these tests permit about twenty percent of the more able children to enter several higher types of schools, including the *gymnasium*. The remaining eighty percent continue through the upper part of the *volksschule* until the school-leaving age of fourteen. "The instruction at the *Volksschule* . . . is inferior in comparison to the secondary education the other twenty percent receive. *Heimatkunde* (a study of local geography and history) is discontinued; offerings in history, geography, and elementary natural science take its place."[5]

[5] Pilgert, Henry P. "The West German Education System." Office of the U. S. High Commissioner for Germany, 1953. United States Government Printing Office, Washington 25, D. C.

According to Pilgert,[6] natural sciences occupy about ten percent of the instructional time in the upper grades (five to eight) of the *volksschule.* A higher school, especially a mathematics-science *gymnasium* which an exceptionally talented child might enter, would doubtless have a much higher percentage of time devoted to science and mathematics.

Hurd[7] found that biology was taught two hours a week in grades five to eight. UNESCO figures[8] indicate that science (including biology, chemistry, and physics topics) is taught for about two and a quarter hours per week in the fifth and sixth years. The UNESCO figures presumably refer, with minor variation, to *volksschulen* in all of the *länder.*

Mathematical instruction is included in *heimatkunde* in the first four years of the *volksschule,* but the UNESCO data do not indicate time allotments. Three hours a week of mathematics are required in grades five and six. Figures for science and mathematics in German primary schools are shown in Table III. Comparison of these figures with the average number of hours for science and mathematics in American schools (Table I) shows that somewhat less time per week is devoted to both subjects in German *volksschulen.*

TABLE III. TIME ALLOTMENTS IN GERMAN SCHOOLS

	School Year					
	1	2	3	4	5	6
Science (biology, chemistry, and physics)	0	0	0	0	$2\frac{1}{4}$	$2\frac{1}{4}$
Mathematics	?	?	?	?	3	3

An analysis of German and American textbook content[9] indicates that multiplication and division tables, adding and subtracting fractions with the same denominators and multiplying integers by decimals are topics which are taken up two years earlier in German schools. Such topics as division by a one-digit number with carrying, division by two- and three-digit numbers, multiplication and division of integers by fractions, and percentage are covered one year earlier in Germany. (See Table II.)

THE NETHERLANDS

"The program of study is not exactly the same in every part of

[6] Pilgert, Henry P., *op. cit.*, p. 47.
[7] Hurd, Paul DeH., *op. cit.*, p. 6.
[8] "World Survey of Education, II, Primary Education." United Nations Educational, Scientific and Cultural Organization. Switzerland. 1958. p. 461.
[9] Schutter, Charles H., *loc. cit.*

the country, since each school or each city is free to adopt its own curriculum as long as it meets legal requirements. . . ."[10] Male[11] indicates the 1958 curriculum of a typical elementary school in which natural history and natural and physical sciences were considered as two separate subjects. Natural history was taught for an hour and a half per week in the fourth through the sixth grades, and natural and physical sciences for an hour a week in those same grades.

Unpublished material supplied by the cultural attaché of the Netherlands embassy gives the following information about the number of hours of science and mathematics in another elementary school:

TABLE IV. TIME ALLOTMENTS IN A TYPICAL SCHOOL IN THE NETHERLANDS

	School Year					
	1	2	3	4	5	6
Natural History	1	½	1	1	1	1
Arithmetic	4½	5	6	5¼	5¼	5¼

Compare these figures with ones for the United States in Table I. The amount of time devoted to science is somewhat greater in the United States; and to mathematics, much greater in the Netherlands.

In the first two grades of the latter school natural history dealt with a study of the immediate environment and animal protection. In the third grade, domestic animals, birds, flowers, plants, and animal protection were studied. Fourth year science covered lesser known plants and animals, fifth year science covered exotic plants and animals and animal protection, and sixth year science covered the human body, hygiene, cultivated plants, magnetism, electricity, engines, motors, radio, and aeroplanes.

The outline below indicates the nature of the arithmetic curriculum in this school:

1st year: The figures from 1–20. Counting up to 1000.
2nd year: Principle operations with figures from 1–100. Roman numerals I–XII. Clock-reading. Reckoning with coins. Measuring: meter, decimeter, centimeter. Counting up to 100.
3rd year: Principle operations with figures from 1–10,000. Object-teaching of linear measures, weights, and cubic measures. Adding and subtracting with figures up to 10,000.
4th year: Principle operations with larger numbers. Surface, circumference, volume. Roman numerals. Vulgar fractions.
5th year: All about vulgar fractions. Decimal fractions. The metric system. Reasoned solution of simple problems. Sums. Percent. Ratio.

[10] Male, George A. "Teacher Education in the Netherlands, Belgium, and Luxemburg." Bulletin 1960, No. 4, U. S. Department of Health, Education, and Welfare. Washington, D. C. 1960. p. 7.
[11] Male, George A., *op. cit.*, p. 8.

6th year: Practical sums and reasoned sums, also in connection with the qualifications for the entrance examinations of secondary schools. Characteristics of divisibility. Simple geometric figures.

Table II, showing grade placement of topics in arithmetic programs, indicates that a majority of the topics are studied a year earlier in the Netherlands than in the United States.

Scandinavian Countries

Sweden

A new primary curriculum was introduced in Sweden in 1955. In it the seven-year primary school is subdivided into a two-year junior school and a five-year upper school. Science, called "nature knowledge," is required from the fourth year of the primary school on.[12]

Table V. Time Allotments in Sweden

	School Year					
	1	2	3	4	5	6
Nature Knowledge	—	—	—	2	2	2
Mathematics	4	4	5	5	5	5

Tables I and V show that more time is devoted to science in the United States than in Sweden, and that the reverse is true for mathematics.

Hurd's study indicates that "nature knowledge" consists largely of biology[13] combined with geography. The themes for this subject are the needs of plants and animals, human living conditions and the laws of hygiene.

UNESCO figures[14] indicate that the amount of time spent on mathematics in Swedish primary schools is considerable amounting to four hours a week in the first two grades and five in grades three through seven. A comparison of the levels at which topics in arithmetic are introduced in Sweden and in the United States indicates Sweden to be somewhat in advance in the study of arithmetic topics. (See Table II.)

Norway

A representative Norwegian primary school timetable[15] shows that science is not taught in the first three grades and that it occupies

[12] UNESCO *op. cit.*, p. 941–2.
[13] Hurd, Paul DeH., *op. cit.* p. 6 and 47.
[14] UNESCO, *loc. cit.*
[15] UNESCO, *op. cit.*, p. 804.

three 45-minute periods a week in the fourth and fifth grades and two periods in grades six and seven. (Table VI gives this information in hours per week.)

TABLE VI. TIME ALLOTMENTS IN AN URBAN PRIMARY SCHOOL FOR BOYS IN NORWAY

	School Year					
	1	2	3	4	5	6
Natural Science	—	—	—	$2\frac{1}{4}$	$2\frac{1}{4}$	$1\frac{1}{2}$
Arithmetic	$2\frac{1}{4}$	3	3	$3\frac{3}{4}$	$3\frac{3}{4}$	$3\frac{3}{4}$

Hurd indicates that the aims in science in an elementary school he visited were: "To give the pupils an idea of the structure, the life and the development of the most important Norwegian plants and animals, and their dependence on their environment; to give them some knowledge of the plants and animals of other countries."

"To awaken in the children an interest and love for the manifestations of animal and plant life that they can observe, so as to do away with all useless destruction and to encourage deeds making for the protection of animals and of nature."

"To give the pupils some knowledge of the human body and of evolution, and to teach them the most important rules of hygiene so as to render them capable of looking after their own health."[16]

In the same Norwegian primary school for boys, the arithmetic time allotment[17] is three 45-minute periods per week in grade one, four in grades two and three, and five in grades four through seven. Table II does not contain data for grade placement of arithmetic topics in Norway.

Denmark

The timetable for a primary school in Copenhagen allots the following number of fifty-minute periods to science: grades one and two, none; grades three and four, one; and grade five, two.[18] The arithmetic schedule in this school is four periods per week in the first grade and five periods for each grade thereafter. Table VII gives this information in terms of hours per week. Again, comparing Tables I and VII, American schools provide more time for science and less for mathematics than do Danish schools.

Hurd finds the following objectives for elementary science in the syllabus of another school:

[16] Hurd, Paul DeH., *op. cit.*, p. 39.
[17] UNESCO, *op. cit.*, p. 804.
[18] "Educational Data: Kingdom of Denmark." U. S. Office of Education Bulletin No. 10 (revised). June 1960.

TABLE VII. APPROXIMATE TIME ALLOTMENTS FOR A DANISH PRIMARY SCHOOL

	School Year				
	1	2	3	4	5
Natural History	—	—	1	1	$1\frac{1}{2}$
Arithmetic	$3\frac{1}{2}$	4	4	4	4

"The instruction should enable a child to gain a knowledge of the animals and plants of Denmark and of the principal animals and plants of other countries."

"The study of natural science should also develop the power of observation and, through the understanding of biological laws, fill the child with an appreciation of nature and a sense of her beauty and diversity."[19]

No data were available on the levels at which arithmetic topics are taught in Denmark.

SWITZERLAND

Each of the twenty-five cantons of Switzerland is a sovereign state within the framework of the federal constitution. There are, therefore, twenty-five sets of educational laws and no federal regulations as to curricula, textbooks, or examinations. As a result, there is great variation from canton to canton.

In the canton of Vaud, science is given in the form of object lessons in all elementary grades. In Zurich, it is combined with geography and history and taught for four to six periods a week in the fourth to sixth grades and, as a separate subject, for two periods a week in the seventh and eighth grades. And in Geneva it is combined with ethics for a period a week in grades one through seven. In addition, there may be variation in science content within a canton on the basis of sex, the nature of the community (urban or rural), and the season of the year.[20] Variation in time allotments in Switzerland was so great that no attempt was made to present this information in tabular form.

Hurd gives the objectives of science teaching in one canton in Switzerland:

"The aims of the teaching of elementary natural science are not always stated in the official instructions. When such aims are mentioned they may be divided into two categories. The first category covers all that aims at the acquisition of a method, for example at

[19] Hurd, Paul DeH., *op. cit.* p. 22.
[20] UNESCO, *op. cit.*, p. 954–8.

the development of observation and the ability to reason from observation. The other category of aims comprises what is to be gained through the acquisition of such habits of mind."

"In the Canton of Vaud, it is pointed out that in schools at the present time, education plays a more important part than instruction, and that this means that the child's mind is not to be stuffed with facts, but moulded."[21]

In Vaud, arithmetic, geometry, and bookkeeping are combined and given from three to six periods a week during the whole primary school period. In Zurich, arithmetic and geometry are begun and taught together in grade four. Geneva requires four or five periods a week of arithmetic in grades two through seven.[22]

Unfortunately, data on Switzerland were not included in Table I which shows grade placement of arithmetic topics.

France

Primary education is compulsory for French boys and girls between six and fourteen years of age. The entire period of compulsory education for the school-leaving class may be spent in an elementary primary school. Children of greater ability, on reaching age eleven, are sent to an academic secondary lycée or collège, or to a general or vocational school.

"Elementary primary studies are organized as follows: preparatory section, from six to seven years of age; elementary course, from seven to nine; intermediate course, from nine to eleven; higher course, from eleven to twelve; school-leaving course, from twelve to fourteen."[23] The following chart shows the elementary school science and mathematics requirements in hours per week:

Table VIII. Time Allotments in French Schools

	Preparatory Section	Elementary Course	Intermediate and Higher Course	School-leaving Course
Science	—	1 (observation work)	2 (observation work)	6 (elementary applied science, practical work, and drawing)
Mathematics	$3\frac{3}{4}$	$3\frac{3}{4}$	5	5 (arithmetic and practical application)

[21] Hurd, Paul DeH., *op. cit.*, p. 48.
[22] UNESCO, *op. cit.*, p. 954–8.
[23] UNESCO, *op. cit.*, p. 385.

A comparison of these figures with those for the United States (Table I) indicates that, except in the school-leaving course, less science is taught in primary schools in France.

"Timetables and curricula are the same for rural and urban schools, but in the school-leaving class science teaching is given a utilitarian slant, varying according to local conditions. It relates to agriculture in the rural areas and to industry in the town, and it differs for boys and girls. Part of the curriculum is the same for all schools: man in his environment (theory and corresponding practical work), human activities, home occupations."

"In rural boys' schools special attention is accorded to the study of the soil, crops and cattle-breeding. Pupils at urban and rural girls' schools are given elementary instruction in domestic economy—diet, housekeeping, handwork, and child care."[24]

Teachers in the preparatory grades begin to teach science and other subjects by using objects which children can see and touch, helping them to compare, generalize and reason using real objects at first before proceeding to the abstract in higher grades. Inductive and deductive methods of thinking are used later. And experimental work (learning by doing) is preferred to passive observation (learning by seeing).

Tables I and VIII indicate that considerable time is spent in the study of mathematics in the French elementary school. Schutter's figures in Table II indicate that four topics of arithmetic are taught two years earlier than they are in the United States, and that all but two of the remainder are taught one year earlier.

Summary and Recommendations

1. Science is far from being a universal subject in elementary schools in Western Europe. In those countries in which it is taught, it is usually taught for fewer years and/or for fewer hours per week than in the United States.

2. Mathematics, on the contrary, has more time devoted to it in Western European schools and topics are frequently placed one or two grades lower than in the United States. Lower grade placement and greater expenditure of time in mathematics may have a favorable effect on secondary school science in Western Europe.

3. A comprehensive study should be made to gather detailed information on existing elementary school science and mathematics programs in Western Europe. This should include teacher training, content, and teaching methods.

4. Postwar changes have taken place in nursery school education,

---

[24] UNESCO, *op. cit.*, p. 386.

teacher training, examination and guidance systems, and other aspects of education in Western Europe. In many places the school-leaving age has been raised and an effort made to provide a higher education for more individuals. The United States, as well as the countries involved, will be interested in studying and evaluating the effects of these reforms on primary, secondary, and higher education.

Central Association of Science and Mathematics Teachers

Report of the 1961 Nominating Committee*

The nominating committee chairman expresses deep appreciation to Dr. Cecil B. Read, President of CASMT, for having provided an enthusiastic, cooperative and devoted committee membership.

The nominating committee is grateful to the CASMT administrative officers, past presidents, section officers and many other interested members for their generous response to our letters soliciting the names of possible nominees for the offices to be filled.

With a sense of accomplishment and deep satisfaction, it is a privilege to submit the following slate of candidates for the 1961 election:

For President:

Sister Mary Ambrosia Holy Redeemer High School Detroit, Michigan	Alice Hach Public Schools Ann Arbor, Michigan

For Vice-President:

T. Reginald Porter University of Iowa Iowa City, Iowa	Joseph J. Urbancek Chicago Teachers College Chicago, Illinois

For Board of Director Memberships:

Charles Brumfiel Ann Arbor, Michigan	Robert R. Hurst Evanston, Illinois
Calvin W. Gale Madison, Wisconsin	Rev. Leo J. Klosterman, C.S.B. Detroit, Michigan
Julian Greenlee Pontiac, Michigan	Illa Podendorf Chicago, Illinois
E. W. Hamilton Cedar Falls, Iowa	Bruce Westling Grosse Pointe, Michigan

* Members of Committee: Brother William Fitch, C.S.C., Gilmour Academy, Gates Mills, Ohio; Dr. Clyde T. McCormick, Illinois State Normal University, Normal, Illinois; Dr. Gerald Osborne, Western Michigan University, Kalamazoo, Michigan; Mrs. Marie S. Wilcox, T. C. Howe High School, Indianapolis, Indiana; Mr. William A. Hill, Chairman, Naperville Community High School, Naperville, Illinois.

National Science Foundation Announcement of · · ·

In-Service Institutes for Science and Mathematics Teachers, 1961–62

Introduction

The In-Service Institutes program of the National Science Foundation provides opportunities for approximately 11,000 secondary school teachers of science and mathematics, grades 7 through 12, plus a limited number of elementary school teachers, supervisors, and principals, to return to college on a part-time basis. The colleges and universities participating in this program offer instruction during the academic year at times so chosen that teachers can attend while still teaching full-time in their schools—e.g., late afternoons, evenings, or Saturdays. A typical institute meets once or twice a week for two or more hours during the entire academic year, with some meetings devoted to laboratory or field work.

In-Service Institutes are designed and conducted by individual universities and colleges to satisfy a variety of needs for teachers of science and mathematics. Many institutes enable teachers who may have received little formal scientific education beyond that of their undergraduate preparation to obtain additional knowledge of subject matter. Others are designed to acquaint teachers with the important new textual and laboratory materials, as well as visual aids, developed by an ever-increasing number of study groups. Some institutes are planned to offer a sequence of courses over a period of years which may afford participants the opportunity to complete, on a part-time basis, a master's degree program.

Eligibility

1. *Secondary School Personnel*

Teachers of science or mathematics, or both, in grades 7 to 12 in public, private, or parochial schools are eligible to apply for admission to the Institutes listed on pages 419–30 and to receive National Science Foundation support. Supervisors of instruction in mathematics or the sciences in secondary schools are also eligible to participate provided that this is their primary responsibility.

2. *Elementary School Personnel*

Elementary school teachers in grades 1–6, supervisors, and principals concerned with instruction and curricular materials in science and mathematics are eligible for participation in the Institutes listed on pages 419–30 of this brochure. About 700 individuals will have the opportunity to participate in a continuation of the pilot program begun by the National Science Foundation in 1959–60.

Support

The Foundation grants for the Institutes provide, for the participating teachers, special courses for which there are no charges for tuition or fees, as well as an allowance of up to $10 per year for the purchase of books. A travel allowance of up to 7 cents per mile for commuting expenses is also included.

Inquiries and Applications

Requests for brochures and application forms, as well as other inquiries, should be sent to the appropriate Institute director at the address listed below. All admissions to Institute programs will be administered by the colleges and universities involved on the basis of their own individual requirements. The National Science Foundation plays no part in determining which applicants are to be admitted to the institutes nor can it provide information as to the detailed admission requirements of the sponsoring institutions.

A deadline for receipt of applications is set in each case by the individual Institute director; and is listed in the local brochure. Early submission of applications is urged to guarantee consideration for award of tuition and allowances, although in many cases applications can be considered until the beginning of the course. Other interested individuals may attend institute classes without allowances at the discretion of the director.

INSTITUTES FOR SECONDARY SCHOOL TEACHERS

A list of the Institutes and their locations follows:

IN-SERVICE INSTITUTES FOR SECONDARY SCHOOL TEACHERS

Alabama

UNIVERSITY OF ALABAMA, UNIVERSITY. Dr. C. L. Seebeck, Jr., Department of of Mathematics. *Mathematics*. (Classes to be held in Birmingham, Dothan, and Mobile.) $20,820

TALLADEGA COLLEGE, TALLADEGA. Dr. Cohen T. Simpson, Chairman, Department of Chemistry. *Chemistry, Mathematics*. $5,000

Arizona

ARIZONA STATE UNIVERSITY, TEMPE. Dr. Ernest E. Snyder, Chairman, Department of General Physical Sciences. *Biology, Chemistry, Mathematics, Physics*. $11,140

UNIVERSITY OF ARIZONA, TUCSON. Dr. Millard G. Seeley, Department of Chemistry. *Biology*. $6,180

UNIVERSITY OF ARIZONA, TUCSON. Dr. Arthur H. Steinbrenner, Department of Mathematics. *Mathematics*. $6,570

Arkansas

UNIVERSITY OF ARKANSAS, FAYETTEVILLE. Dr. William R. Orton, Department of Mathematics. *Mathematics*. (Classes to be held in Little Rock.) $8,760

HENDRIX COLLEGE, CONWAY. Dr. John E. Stuckey, Department of Chemistry. *Chemistry, Mathematics*. $16,200

California

UNIVERSITY OF CALIFORNIA, LOS ANGELES 24. Dr. Clifford Bell, Department of Mathematics. *Mathematics*. (Classes to be held in Lancaster, Ontario, Riverside, and Santa Barbara.) $23,370 (4 Institutes)

UNIVERSITY OF CALIFORNIA, LOS ANGELES 24. Dr. Paul B. Johnson, Department of Mathematics. *Mathematics*. (Classes to be held in Glendale and Los Angeles.) $8,900

DOMINICAN COLLEGE OF SAN RAFAEL, SAN RAFAEL. Sister M. Augusta, O.P., Department of Mathematics. *Mathematics, Physical Science*. $9,130

HUMBOLDT STATE COLLEGE, ARCATA. Dr. Orval M. Klose, Department of Mathematics. *Mathematics*. $8,040

LONG BEACH STATE COLLEGE, LONG BEACH 4. Dr. John J. Baird, Department of Biology. *Biology*. $11,600

UNIVERSITY OF REDLANDS, REDLANDS. Dr. Paul R. Gleason, Department of Physics. *Physics*. $10,810

SACRAMENTO STATE COLLEGE, SACRAMENTO 19. Dr. Stanley P. Hughart, Department of Mathematics. *Mathematics, Physical Sciences*. $18,970

UNIVERSITY OF SAN FRANCISCO, SAN FRANCISCO 17. Professor Edward J. Farrell, Department of Mathematics. *Mathematics*. $7,210

SAN JOSE STATE COLLEGE, SAN JOSE 14. Dr. Laurence E. Wilson, Department of Chemistry. *Chemistry, Oceanography*. $13,160

SAN JOSE STATE COLLEGE, SAN JOSE 14. Dr. Rodney E. Anderson, Department of Mathematics. *Mathematics*. $18,270

UNIVERSITY OF SANTA CLARA, SANTA CLARA. Dr. Irving Sussman, Chairman,

Department of Mathematics. *Mathematics.* (Classes to be held in Belmont, Oakland, Salinas, Santa Clara, and Santa Cruz.) $28,500

UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGLES 7. Dr. John W. Reith, Chairman, Department of Geography. *Earth Sciences.* $13,820

UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES 7. Professor Paul A. White, Department of Mathematics. *Mathematics.* $21,670

Colorado

COLORADO COLLEGE, COLORADO SPRINGS. Dr. Richard G. Beidleman, Department of Zoology. *General Science.* $6,130

COLORADO SCHOOL OF MINES, GOLDEN. Dr. James L. Hall, Department of Chemistry. *Chemistry.* $3,340

COLORADO STATE COLLEGE, GREELEY. Dr. Albert J. Hendricks, Jr., Division of the Sciences. *Biology.* $8,140

COLORADO STATE COLLEGE, GREELEY. Dr. O. W. TOLLEFSON, Division of the Sciences. *Earth Sciences.* $4,300

UNIVERSITY OF COLORADO, BOULDER. Dr. Newell Younggren, Department of of Biology. *Biology.* $11,170

UNIVERSITY OF COLORADO, BOULDER. Dr. Burton W. Jones, Chairman, Department of Mathematics. *Mathematics.* (Classes to be held in Denver.) $9,100

WESTERN STATE COLLEGE OF COLORADO, GUNNISON. Dr. Theodore D. Violett, Department of Physics. *Chemistry, Physics.* (Classes to be held in Grand Junction.) $7,730

Connecticut

ALBERTUS MAGNUS COLLEGE, NEW HAVEN 11. Professor Florence D. Jacobson, Chairman, Department of Mathematics. *Mathematics.* (Classes to be held in Hamden.) $10,820

CONNECTICUT COLLEGE, NEW LONDON. Professor Alice T. Schafer, Department of Mathematics. *Mathematics.* $7,320

FAIRFIELD UNIVERSITY, FAIRFIELD. Dr. John A. Barone, Department of Chemistry. *Biology, Mathematics, Physical Science.* $10,230

SAINT JOSEPH COLLEGE, WEST HARTFORT 17. Sister Maria Clare Markham, Department of Chemistry. *Earth Science.* $6,220

Delaware

UNIVERSITY OF DELAWARE, NEWARK. Dr. John A. Brown, Department of Mathematics. *Mathematics.* $4,950

District of Columbia

THE AMERICAN UNIVERSITY, WASHINGTON 16. Dr. Leo Schubert, Chairman, Department of Chemistry. *Biology, Chemistry, Earth Sciences, Mathematics, Physics.* $22,290

DISTRICT OF COLUMBIA TEACHERS COLLEGE, WASHINGTON 9. Professor Daniel B. Lloyd, Chairman, Department of Mathematics. *Mathematics.* $8,400

GEORGETOWN UNIVERSITY, WASHINGTON 7. Reverend Matthew P. Thaekaekara, S.J., Department of Physics. *Physics.* $10,310

Florida

FLORIDA STATE UNIVERSITY, TALLAHASSEE. Professor J. Stanley Marshall, Head, Department of Science Education. *Biology.* (Classes to be held in Miami and Sarasota.) $22,790

FLORIDA STATE UNIVERSITY, TALLAHASSEE. Professor J. Stanley Marshall, Head, Department of Science Education. *General Science.* (Classes to be held in Brevard County.) $9,060

UNIVERSITY OF FLORIDA, Gainesville. Dr. G. Ray Noggle, Head, Department of Botany. *Biology.* (Classes to be held in Jacksonville and Melbourne.) $22,540

UNIVERSITY OF FLORIDA, GAINESVILLE. Dr. N. Eldred Bingham, Department of Science Education. *Biology, Chemistry, Earth Sciences, Mathematics, Physics.* (Classes to be held in Tampa.) $28,710

UNIVERSITY OF FLORIDA, GAINESVILLE. Dr. Casper Rappenecker, Department of of Geology. *Earth Sciences, Mathematics.* (Classes to be held in Jacksonville.) $15,380

UNIVERSITY OF FLORIDA, GAINESVILLE. Dr. Kenneth P. Kidd, Department of Secondary Education. *Mathematics.* (Classes to be held in Orlando.) $15,320

UNIVERSITY OF MIAMI, CORAL GABLES. Dr. J. H. CURTISS, Department of Mathematics. *Mathematics.* $19,850

STETSON UNIVERSITY, DELAND. Dr. Gene W. Medlin, Chairman, Department of Mathematics. *Mathematics.* $6,850

Georgia

ALBANY STATE COLLEGE, ALBANY. Dr. William E. Johnson, Jr., Chairman, Department of Science. *Biology, Chemistry, Mathematics.* $19,180

EMORY UNIVERSITY, ATLANTA 22. Dr. Charles T. Lester, Dean, Graduate School of Arts and Sciences. *Chemistry, Mathematics.* $10,940

UNIVERSITY OF GEORGIA, ATHENS. Dr. Charles L. Koelsche, College of Education. *Biology, Earth Sciences, Physical Science.* (Classes to be held in Augusta.) $13,000

SHORTER COLLEGE, ROME. Professor Lewis Lipps, Department of Biology. *Biology, Chemistry, Earth Sciences, Physics.* $13,510

Hawaii

UNIVERSITY OF HAWAII, HONOLULU 14. Dr. Michael M. Frodyma, Department of Chemistry. *Biology.* $3,470

UNIVERSITY OF HAWAII, HONOLULU 14. Dr. Jimmie B. Smith, Department of Botany. *Chemistry, Physics.* (Classes to be held in Hilo and Maui.) $10,430

Idaho

RICKS COLLEGE, REXBURG. Professor Merle R. Fisher, Department of Mathematics and Physical Science. *Physics.* $7,620

Illinois

BARAT COLLEGE, LAKE FOREST. Dr. Charlotte Dames, Chairman, Department of Physical Science. *Earth Sciences, Mathematics, Physical Science.* $10,050

DEPAUL UNIVERSITY, Chicago 4. Professor Willis B. Caton, Department of Mathematics. *Mathematics.* $12,370

ILLINOIS INSTITUTE OF TECHNOLOGY, CHICAGO 16. Dr. Haim Reingold, Chairman, Department of Mathematics. *Biology, Chemistry, Mathematics, Physics.* $60,550

NORTHWESTERN UNIVERSITY, EVANSTON. Professor E. H. C. Hildebrandt, Department of Mathematics. *Mathematics.* $11,520

Indiana

BALL STATE TEACHERS COLLEGE, MUNCIE. Dr. P. D. Edwards, Head, Department of Mathematics. *Mathematics.* $15,020

BUTLER UNIVERSITY, INDIANAPOLIS 7. Professor Harry E. Crull, Head, Department of Mathematics. *Mathematics.* $9,750

EARLHAM COLLEGE, RICHMOND. Dr. Roland F. Smith, Department of Mathematics. *Mathematics.* $4,200

INDIANA CENTRAL COLLEGE, INDIANAPOLIS 27. Dr. Robert M. Brooker, Department of Chemistry. *General Science.* $7,680

PURDUE UNIVERSITY, LAFAYETTE. Dr. Joseph D. Novak, Department of Biology. *Biology.* (Classes to be held in Evansville, Fort Wayne, Hammond, Indianapolis, and Michigan City.) $39,450

PURDUE UNIVERSITY, LAFAYETTE. Dr. M. Wiles Keller, Department of Mathe-

matics. *Mathematics*. (Classes to be held in Calumet, Evansville, Fort Wayne, Indianapolis, and Lafayette.) $43,480

Iowa

DRAKE UNIVERSITY, DES MOINES 11. Dean Earle L. Canfield, Graduate Division. *Biology, Mathematics, Physics*. $15,570

STATE UNIVERSITY OF IOWA, IOWA CITY. Professor Robert E. Yager, Department of Science Education. *Biology, Earth Science, Physical Science*. $15,860

Kansas

KANSAS STATE COLLEGE OF PITTSBURG, PITTSBURG. Dr. R. G. Smith, Chairman, Department of Mathematics. *Biology, Mathematics*, $13,800

KANSAS STATE TEACHERS COLLEGE, EMPORIA. Professor Ted F. Andrews, Head, Department of Biology. *Biology, Mathematics, Physics*. $24,330

Kentucky

UNIVERSITY OF LOUISVILLE, LOUISVILLE. Dr. Bruce B. Vance, Department of Physics. *Physics*. $5,100

MURRAY STATE COLLEGE, MURRAY. Dr. Alfred Wolfson, Head, Department of Biology. *Chemistry, Mathematics, Physics*. $9,780

WESTERN KENTUCKY STATE COLLEGE, BOWLING GREEN. Dr. Ward C. Sumpter, Department of Chemistry. *Biology, Earth Sciences, Mathematics, Physical Science*. $12,050

Louisiana

CENTENARY COLLEGE, SHREVEPORT. Dr. Virginia Carlton, Head, Department of Mathematics. *Mathematics*, $6,700

LOUISIANA COLLEGE, PINEVILLE. Professor Henry Donohoe, Chairman, Department of Mathematics. *Mathematics*. $6,990

LOUISIANA STATE UNIVERSITY, BATON ROUGE. Dr. Henry G. Jacob, Jr., Department of Mathematics. *Mathematics*. (Classes to be held in Bastrop, Baton Rouge, and New Orleans.) $12,970

LOYOLA UNIVERSITY, NEW ORLEANS 18. Reverend H. R. Jolley, S.J., Department of Chemistry. *Chemistry*. $10,320

LOYOLA UNIVERSITY, NEW ORLEANS, 18. Reverend John F. Keller, S.J., Chairman, Department of Mathematics. *Mathematics*. $8,920

LOYOLA UNIVERSITY, NEW ORLEANS 18. Reverend F. A. Benedetto, S.J., Chairman, Department of Physics. *Physics*. $8,290

MCNEESE STATE COLLEGE, LAKE CHARLES. Dr. S. M. Spencer, Head, Department of Mathematics. *Biology, Mathematics*. $10,060

SOUTHERN UNIVERSITY AND A. AND M. COLLEGE, BATON ROUGE. Dr. Russell M. Ampey, Department of Biology. *Biology, Chemistry*. $8,470

UNIVERSITY OF SOUTHWESTERN LOUISIANA, LAFAYETTE. Dr. James R. Oliver, Department of Chemistry. *Biology, Chemistry, Mathematics, Physics*. $26,100

Maryland

UNIVERSITY OF MARYLAND, COLLEGE PARK. Dr. Richard A. Good, Department of Mathematics. *Mathematics*. $16,690

UNIVERSITY OF MARYLAND, COLLEGE PARK. Dr. Howard Laster, Department of Physics. *Physics*. $20,740

Massachusetts

BOSTON COLLEGE, CHESTNUT HILL 67. Reverend Stanley J. Bezuszka, S.J., Chairman, Department of Mathematics. *Mathematics*. $15,850

BOSTON COLLEGE, CHESTNUT HILL 67. Reverend William G. Guindon, S.J., Chairman, Department of Physics. *Physics*. $6,290

EASTERN NAZARENE COLLEGE, WOLLASTON 70. Dr. P. Calvin Maybury, Chairman, Department of Chemistry. *Mathematics, Physical Science, Physics*. $13,130

College of the Holy Cross, Worcester 10. Reverend John W. Flavin, S.J., Department of Biology. *Biology*, $6,240

College of the Holy Cross, Worcester 10. Dr. William E. Hartnett, Department of Mathematics. *Mathematics*. $10,570

State College at Salem, Salem. Professor Thomas I. Ryan, Department of Biology. *Biology. Chemistry, Earth Sciences, Mathematics*. $15,200

Worcester Polytechnic Institute, Worcester. Professor Richard F. Morton, Department of Physics. *Physics, Biology*. $13,460

Michigan

Andrews University, Berrien Springs. Professor Harold T. Jones, Department of Mathematics. *Mathematics*. $3,730

Central Michigan University, Mount Pleasant. Dr. Lauren G. Woodby, Department of Mathematics. *Mathematics*. $22,040

Central Michigan University, Mount Pleasant. Dr. Malcolm H. Filson, Head, Department of Physics and Chemistry. *Physical Science*. $10,290

University of Detroit, Detroit, 21. Dr. Lyle E. Mehlenbacher, Chairman, Department of Mathematics. *Mathematics*. $13,580

University of Michigan, Ann Arbor. Professor Charles Brumfiel, Department of Mathematics. *Mathematics*. $11,450

Northern Michigan College, Marquette. Dr. W. James Merry, Department of Biology. *Biology*. (Classes to be held at Hancock and Marquette.) $10,700

Wayne State University, Detroit 2. Dr. William V. Mayer, Chairman, Department of Biology. *Biology*. $8,180

Wayne State University, Detroit 2. Professor Harold T. Sloby, Department of Mathematics. *Mathematics* $9,250.

Western Michigan University, Kalamazoo, Dr. George G. Mallinson, Dean, School of Graduate Studies. *Earth Sciences and Physical Science, Mathematics*. (2 institutes) $20,910

Minnesota

Bemidji State College, Bemidji. Professor W. Richard Slinkman, Department of Mathematics. *Mathematics*. $5,970

St. Cloud College, St. Cloud. Dr. Harold Hopkins, Department of Biology. *Biology*. $3,220

Mississippi

Mississippi College, Clinton. Dr. Archie H. Germany, Head, Department of Chemistry. *Biology, Mathematics, Physics*. $16,790

Mississippi Southern College, Hattiesburg. Dr. Virginia Felder, Department of Mathematics. *Mathematics*. $9,560

Mississippi State University, State College. Dr. R. D. Boswell, Jr., Department of Mathematics. *Mathematics*. (Classes to be held in Greenwood, Meridian, New Albany, and State College.) $10,690

Missouri

Central Missouri State College, Warrensburg. Dr. Charles E. Kelley, Department of Mathematics. *Mathematics*. $8,110

Missouri School of Mines and Metallurgy, Rolla. Dr. Harold Q. Fuller, Department of Physics. *Earth Sciences, Mathematics*. $9,330

Rockhurst College, Kansas City 10. Reverend William C. Doyle, Department of Mathematics. *Mathematics*. $8,050

Saint Louis University, St. Louis 3. Dr. John J. Andrews, Department of Mathematics. *Mathematics*. $3,990

William Jewell College, Liberty. Dr. Wallace A. Hilton, Department of Physics. *Biology, Chemistry, Mathematics, Physics*. $11,400

Montana

Eastern Montana College of Education, Billings. Professor Oliver W. Peterson, Department of Science. *Mathematics*. $5,110

Montana State University, Missoula. Dr. William R. Ballard, Department of Mathematics. *Mathematics*. (Classes to be held in Glendive, Great Falls, Kalispell, Miles City, Missoula and Ellensburg, Washington.) $19,590

Montana State University, Missoula. Dr. James W. Gebhart, School of Education. *Radiation Biology*. (Jointly sponsored by the Atomic Energy Commission.) $3,530

Nebraska

Nebraska Wesleyan University, Lincoln 4. Dr. Walter R. French, Jr., Department of Physics. *Physics*. $13,600

University of Omaha, Omaha. Dr. Merle E. Brooks, Department of Biology. *Biology, Mathematics, Physical Science*. $20,820

Nevada

University of Nevada, Reno. Dr. E. M. Beesley, Chairman, Department of Mathematics. *Mathematics*. $15,450

New Hampshire

Dartmouth College, Hanover. Professor Charles J. Lyon, Department of Botany. *Biology*. $4,620

University of New Hampshire, Durham. Dr. Shepley L. Ross, Department of Mathematics. *Mathematics*. $13,470

New Jersey

Drew University, Madison. Dr. Bernard Greenspan, Department of Mathematics. *Mathematics*. $5,160

Glassboro State College, Glassboro. Dr. Warren G. Roome, Department of Mathematics. *Mathematics*. $13,050

Montclair State College, Upper Montclair. Dr. Max A. Sobel, Department of Mathematics. *Mathematics*. $12,150

Newark College of Engineering, Newark 2. Professor Herbert Barkan, Department of Mathematics. *Chemistry, Mathematics, Physics*. $7,800

Newark College of Engineering, Newark 2. Dr. Charles Koren, Department of Mathematics. *Mathematics*. $3,670

Newark College of Engineering, Newark 2. Dr. Paul O. Hoffman, Department of Physics and Mechanics. *Physics*. $4,430

Rutgers—The State University, New Brunswick. Professor Joshua Barlaz, Department of Mathematics. *Mathematics*. (2 institutes) $24,660

Saint Peter's College, Jersey City 6. Dr. Frank J. McMackin, Department of Mathematics. *Mathematics*. $9,450

Trenton State College, Trenton 5. Dr. Robert Vincent Price, Department of Mathematics. *Mathematics*. $10,850

New Mexico

University of New Mexico, Albuquerque. Dr. Merle Mitchell, Department of Mathematics. *Mathematics*. $5,230

New York

Adelphi College, Garden City, Long Island. Professor Donald Solitar, Department of Mathematics. *Mathematics*. $39,140

Brooklyn College, Brooklyn 10. Dr. Meyer Jordan, Department of Mathematics. *Mathematics*. $6,060

The University of Buffalo, Buffalo 14. Professor Harriet F. Montague, Department of Mathematics. *Mathematics*. $6,520

The University of Buffalo, Buffalo 14. Dr. Edith R. Scheckenburger, Department of Mathematics. ***Mathematics.*** **$6,750**

City College, New York 31. Professor W. I. Pearman, Department of Education. *Mathematics, Physics.* $18,450 (2 institutes)

Teachers College, Columbia University, New York 27. Professor Harold F. Fehr, Head, Department of the Teaching of Mathematics. *Mathematics.* $14,600

Cornell University, Ithaca. Professor R. William Shaw, Department of Astronomy. *Earth Sciences.* $12,950

Fordham University, New York 58. Reverend Charles J. Lewis, S.J., Chairman, Department of Mathematics. *Mathematics.* $11,740

Hobart and William Smith Colleges, Geneva. Dr. Robert L. Beinert, Department of Mathematics. *Mathematics.* $3,520

Hunter College, New York 21. Dr. Jewell Hughes Bushey, Chairman, Department of Mathematics. *Mathematics.* $14,090

Manhattan College, New York 71. Professor Arthur B. Kemper, Head, Department of Chemistry. *Chemistry.* $6,100

Manhattan College, New York 71. Brother Bernard Alfred Welch, Department of Mathematics. *Mathematics.* $11,240

Manhattan College, New York 71. Professor Luke V. Titone, Department of Physics. *Physics.* $11,270

New York University, New York 3. Professor Morris Kline, Chairman, Department of Mathematics. *Mathematics.* $26,430

Pace College, New York 38. Dr. Edward Ritter, Chairman, Department of Natural Sciences. *Biology, Chemistry, Mathematics.* $13,920

Queens College, Flushing 67. Dr. Nathan S. Washton, Department of Education. *Mathematics.* $12,790

Sarah Lawrence College, Bronxville 8. Dr. Edward J. Cogan, Chairman, Science Faculty. *Biology, Chemistry, Mathematics.* $14,620

State University College of Education at Oneonta, Oneonta. Dr. Emery L. Will, Chairman, Department of Science. *Earth Sciences, General Science.* $5,490

Union College, Schenectady 8. Professor C. W. Graves, Department of Psychology. *Biology, Chemistry, Earth Sciences, Mathematics.* $17,720

Yeshiva University, New York 33. Dean Abe Gelbart, Graduate School of Science. *Mathematics, Physics.* $72,500

North Carolina

The Agricultural and Technical College of North Carolina, Greensboro. Dr. George C. Royal, Jr., Department of Biology. *Earth Sciences, Physical Science, Biology.* $9,750

University of North Carolina, Chapel Hill. Dr. Sherwood Githens, Jr., Box C.M. Duke Station, Durham, N. C. *Physics.* (Classes to be held in Burlington.) $5,080

University of North Carolina, Chapel Hill. Dr. William A. White, Department of Geology and Geography. *Earth Sciences.* (Classes to be held in Fayetteville.) $8,300

North Carolina State College, Raleigh. Dr. H. V. Park, Department of Mathematics. *Mathematics.* $6,770

Wake Forest College, Winston-Salem. Dr. Ben M. Seelbinder, Department of Mathematics. *Mathematics.* $6,350

The Woman's College of the University of North Carolina, Greensboro. Dr. Hollis J. Rogers, Department of Biology. *Biology, Earth Sciences, Physics.* $17,000

North Dakota

North Dakota State University, Fargo. Professor Joel W. Broberg, College of Chemical Technology. *Physical Science.* (Classes to be held in Jamestown, Mandan, and Minot.) $13,440

Ohio

THE UNIVERSITY OF AKRON, AKRON 4. Dr. Mabel M. Riedinger, College of Education. *Mathematics, Physics.* $8,580

BALDWIN-WALLACE COLLEGE, BEREA. Dr. Dean L. Ross, Department of Mathematics. *Mathematics.* $4,590

BOWLING GREEN STATE UNIVERSITY, BOWLING GREEN. Dr. W. H. Hall, Department of Chemistry. *Chemistry.* $5,670

CAPITAL UNIVERSITY, COLUMBUS 9. Dr. Clarence H. Heinke, Department of Mathematics. *Mathematics.* $6,870

UNIVERSITY OF CINCINNATI, CINCINNATI 21. Professor I. A. Barnett, Department of Mathematics. *Mathematics.* $17,900

UNIVERSITY OF DAYTON, DAYTON 9. Dr. K. C. Schraut, Chairman, Department of Mathematics. *Mathematics.* $8,660

JOHN CARROL UNIVERSITY, CLEVELAND 18. Reverend Henry F. Birkenhauer, S.J., Department of Mathematics. *Mathematics.* $3,960

KENT STATE UNIVERSITY, KENT. Dr. Kenneth B. Cummins, Department of Mathematics. *Mathematics.* (Classes to be held in Cleveland and Kent.) $14,610 (2 institutes)

THE OHIO STATE UNIVERSITY, COLUMBUS 10. Dr. William R. Riley, Department of Physics. *Physics.* $10,410

THE UNIVERSITY OF TOLEDO, TOLEDO 6. Professor Archie N. Solberg, Chairman, Department of Biology. *Biology, General Science.* $15,280

THE UNIVERSITY OF TOLEDO, TOLEDO 6. Dr. Carroll E. Amos, Department of Mathematics. *Mathematics.* $9,410

YOUNGSTOWN UNIVERSITY, YOUNGSTOWN. Dr. Clair L. Worley, Head, Department of Biology. *Earth Sciences.* $5,460

Oklahoma

CENTRAL STATE COLLEGE, EDMOND. Dr. Earl C. Rice, Department of Mathematics. *Mathematics.* $8,390

NORTHWESTERN STATE COLLEGE, ALVA. Dr. J. Louis Bouchard, Department of Biology. *Biology.* $6,490

THE UNIVERSITY OF OKLAHOMA, NORMAN. Dr. Richard V. Andree, Department of Mathematics. *Mathematics.* $27,650

SOUTHEASTERN STATE COLLEGE, DURANT. Dr. Leslie A. Dwight, Head, Department of Mathematics. *Mathematics.* (Classes to be held in Healdton.) $5,630

SOUTHEASTERN STATE COLLEGE, DURANT. Dr. Ernest E. Sturch, Jr., Department of Physical Science. *Physical Science.* $4,900

Oregon

LEWIS AND CLARK COLLEGE, PORTLAND 19. Dr. Elvy Fredrickson, Chairman, Department of Mathematics. *Chemistry, Mathematics.* $6,590

MARYLHURST COLLEGE, MARYLHURST. Sister M. Loretta Ann, Chairman, Department of Science and Mathematics. *Mathematics.* $5,440

OREGON STATE COLLEGE, CORVALLIS. Dr. W. D. Wilkinson, Department of Geology. *Earth Sciences.* $5,840

OREGON STATE COLLEGE, CORVALLIS. Dr. Albert R. Poole, Department of Mathematics. *Mathematics.* $3,370

UNIVERSITY OF OREGON, EUGENE. Professor A. F. Moursund, Head, Department of Mathematics. *Mathematics.* $3,700

OREGON STATE SYSTEM OF HIGHER EDUCATION, PORTLAND CENTER, PORTLAND. Dr. J. Richard Byrne, Department of Mathematics. *Mathematics.* $4,190

REED COLLEGE, PORTLAND 2. Professor Arthur F. Scott, Department of Chemistry. *Chemistry, Mathematics.* $15,800

Pennnsylvania

ALBRIGHT COLLEGE, READING. Professor Richard J. Kohlmeyer, Department of Mathematics. *Mathematics.* $4,530

ALLEGHENY COLLEGE, MEADVILLE. Dr. Frederick H. Steen, Department of Mathematics. *Mathematics.* $3,090

BUCKNELL UNIVERSITY, LEWISBURG. Dr. William K. Smith, Department of Mathematics. *Mathematics.* $5,740

FRANKLIN AND MARSHALL COLLEGE, LANCASTER. Dr. Bernard Jacobson, Department of Mathematics and Astronomy. *Mathematics.* $10,840

LAFAYETTE COLLEGE, EASTON. Professor B. E. Rhoades, Department of Mathematics. *Mathematics.* $5,640

MOUNT MERCY COLLEGE, PITTSBURGH. Dr. William A. Uricchio, Chairman, Department of Biology. *Biology.* $6,640

THE PENNSYLVANIA STATE UNIVERSITY, UNIVERSITY PARK. Professor William H. Powers, Department of Chemistry. *Biology, Chemistry, Earth Sciences, Mathematics, Physics.* (Classes to be held in Abington, Allentown, Altoona, Dubois, Erie, Hazleton, McKeesport, New Castle, Pottsville, Reading, State College, Uniontown, Wilkes-Barre, and York.) $39,530

UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA 4. Professor J. F. Hazel, Department of Chemistry. *Chemistry, Mathematics.* $12,300

UNIVERSITY OF PITTSBURGH, PITTSBURGH 13. Professor Peter Gray, Head, Department of Biological Sciences. *Biology.* $7,780

UNIVERSITY OF PITTSBURGH, PITTSBURGH 13. Professor John C. Knipp, Department of Mathematics. *Mathematics.* $9,060

UNIVERSITY OF SCRANTON, SCRANTON. Reverend Joseph A. Rock, S. J., Dean, Graduate School. *Biology, Physics.* $9,210

TEMPLE UNIVERSITY, PHILADELPHIA 22. Professor Leonard Muldawer, Department of Physics. *Mathematics, Physics.* $17,330

Puerto Rico

UNIVERSITY OF PUERTO RICO, MAYAGUEZ. Dr. Virgilio Biaggi, Jr., Assistant to the Dean of Arts and Sciences. *Biology, Mathematics, Physics.* $9,230

UNIVERSITY OF PUERTO RICO, RIO PIEDRAS. Dr. Leticia del Rosario, Department of Physics. *Earth Sciences, Mathematics, Physics.* $9,810

UNIVERSITY OF PUERTO RICO, RIO PIEDRAS. Dr. Augusto Bobonis, Dean, College of Education. *Mathematics.* $14,480

Rhode Island

BROWN UNIVERSITY, PROVIDENCE 12. Mr. Charles B. MacKay, Department of Education. *Earth Sciences, General Science.* $6,220

South Carolina

SOUTH CAROLINA STATE COLLEGE, ORANGEBURG. Dr. George W. Hunter, Chairman, Department of Natural Sciences. *Biology, Chemistry, Physics.* $30,470

South Dakota

STATE UNIVERSITY OF SOUTH DAKOTA, VERMILLION. Dr. Theodore L. Reid, Department of Chemistry. *Biology, Chemistry, Mathematics.* $29,360

Tennessee

AUSTIN PEAY STATE COLLEGE, CLARKSVILLE. Dr. William G. Stokes, Head, Department of Mathematics. *Mathematics.* $5,880

UNIVERSITY OF CHATTANOOGA, CHATTANOOGA 3. Dr. Kenneth A. Fry, Department of Biology. *Physics.* $8,020

KNOXVILLE COLLEGE, KNOXVILLE 21. Dr. Robert H. Harvey, Chairman, Department of Mathematics. *Chemistry, Mathematics.* $9,950

LEMOYNE COLLEGE, MEMPHIS 6. Dr. Walter W. Gisson, Chairman, Division of Natural Sciences. *General Science, Mathematics.* $10,920

MEMPHIS STATE UNIVERSITY, MEMPHIS 11. Professor R. W. Johnson, Chairman, Department of Geography. *Earth Sciences, General Science.* $8,400

MIDDLE TENNESSEE STATE COLLEGE, MURFREESBORO. Dr. J. Eldred Wiser,

Head, Department of Chemistry and Physics. *Physical Science.* $7,240

SOUTHWESTERN AT MEMPHIS, MEMPHIS 12. Dr. Arlo I. Smith, Department of Biology. *Biology, General Science.* $9,180

SOUTHWESTERN AT MEMPHIS, MEMPHIS 12. Dr. Jack U. Russell, Department of Mathematics. *Mathematics.* $4,430

UNIVERSITY OF TENNESSEE, MARTIN. Dr. James M. Moore, Department of Biology. *Biology, General Science.* $11,200

TENNESSEE A. & I. STATE UNIVERSITY, NASHVILLE 8. Dr. William N. Jackson, Department of Science Education. *Chemistry, Mathematics.* $18,510

TENNESSEE POLYTECHNIC INSTITUTE, COOKEVILLE. Dr. G. B. Pennebaker, Department of Biology. *Biology, General Science.* $12,540

Texas

THE AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS, COLLEGE STATION. Dr. Edmund C. Klipple, Department of Mathematics. *Mathematics.* (Classes to be held in Jacksonville.) $5,880

EAST TEXAS STATE COLLEGE, COMMERCE. Dr. Robert K. Williams, Department of Biology. *Biology.* $7,310

EAST TEXAS STATE COLLEGE, COMMERCE. Dr. Charles S. Rohrer, Department of Chemistry. *Chemistry, Earth Sciences, Mathematics, Physics.* $12,020

HOWARD PAYNE COLLEGE, BROWNWOOD. Dr. Leonard R. Daniel, Chairman, Division of Science and Mathematics. *Mathematics, Physical Science.* $8,050

INCARNATE WORD COLLEGE, SAN ANTONIO 9. Sister Joseph Marie, C.C.V.I., Head, Department of Biology. *Biology, Chemistry.* $10,300

NORTH TEXAS STATE COLLEGE, DENTON. Dr. Robert C. Sherman, Department of Biology. *General Science, Mathematics.* $15,400

PAN AMERICAN COLLEGE, EDINBURG. Professor Sidney S. Draeger, Department of Mathematics. *Mathematics, Physics.* $10,340

PRAIRIE VIEW AGRICULTURAL AND MECHANICAL COLLEGE, PRAIRIE VIEW. Dr. E. E. O'Banion, Head, Department of Natural Sciences. *Chemistry, General Science, Mathematics.* $18,570

ST. MARY'S UNIVERSITY, SAN ANTONIO 1. Dr. James F. Gray, S.M., Department of Mathematics. *Mathematics.* $9,110

STEPHEN F. AUSTIN STATE COLLEGE, NACOGDOCHES. Dr. W. I. Layton, Head, Department of Mathematics. *Mathematics.* $7,280

TEXAS WOMAN'S UNIVERSITY, DENTON. Dr. Harold T. Baker, Department of Chemistry. *Radiation Biology, Radiation Chemistry.* (Jointly sponsored by the Atomic Energy Commission.) $4,700

Utah

UNIVERSITY OF UTAH, SALT LAKE CITY. Professor E. Allan Davis, Department of Mathematics. *Mathematics.* $8,220

Vermont

NORWICH UNIVERSITY, NORTHFIELD. Professor Edward A. Race, Department of Mathematics. *Mathematics.* $3,060

Virginia

EMORY AND HENRY COLLEGE, EMORY. Mr. George M. Speed, Department of Mathematics. *Mathematics.* $4,220

HAMPTON INSTITUTE, HAMPTON. Dr. Victor H. Fields, Department of Chemistry. *Biology, Chemistry, Mathematics.* $13,800

MADISON COLLEGE, HARRISONBURG. Dr. J. Emmert Ikenberry, Department of Mathematics. *Mathematics.* $5,320

VIRGINIA STATE COLLEGE, PETERSBURG. Dr. Richard H. Dunn, Department of Biology. *Mathematics, Physics.* $7,970

UNIVERSITY OF VIRGINIA, CHARLOTTESVILLE. Dr. William C. Lowry, Department of Mathematics. *Mathematics.* (Classes to be held in Fairfax County, Richmond, and Roanoke-Lynchburg Area.) $16,010

Washington

Holy Names College, Spokane 2. Sister M. Eugene Gautereaux, Chairman, Department of Science. *Biology, Mathematics*. $9,340

University of Washington, Seattle 5. Professor Carl B. Allendoerfer, Department of Mathematics. *Mathematics*. (Classes to be held in Highline School District and Seattle.) $5,430

University of Washington, Seattle 5. Dr. Arthur D. Welander, Laboratory of Radiation Biology. *Radiation Biology*. (Jointly sponsored by the Atomic Energy Commission.) $1,700

Wisconsin

Lawrence College, Appleton. Dr. Robert M. Rosenberg, Department of Chemistry. *Chemistry, Physics*. $9,740

Marquette University, Milwaukee 3. Dr. Arthur G. Barkow, Department of Physics. *Physics*. $6,790

Northland College, Ashland. Dean Jesse M. Caskey. *Earth Sciences, Mathematics, Physics*. $14,850

Wisconsin State College, Eau Claire. Mr. Marshall E. Wick, Department of Mathematics. *Mathematics*. $11,560

INSTITUTES FOR ELEMENTARY-SCHOOL PERSONNEL

This listing designates the host institutions, the director of the institute, the areas of training available, and the amount granted by the Foundation for each institute.

California

Dominican College of San Rafael, San Rafael. Sister M. Augusta, O.P., Department of Mathematics. *Mathematics*. $4,330

Humboldt State College, Arcata. Professor Roy W. Tucker, Department of Mathematics. *Mathematics*. $6,820

Sacramento State College, Sacramento 19. Dr. H. Stewart Moredock, Division of Science and Mathematics. *Mathematics*. $6,080

San Jose State College, San Jose. Dr. James R. Smart, Department of Mathematics. *Mathematics*. $5,870

Colorado

University of Colorado, Boulder. Dr. James R. Wailes, School of Education. *General Science*. $5,640

Florida

Florida State University, Tallahassee. Dr. Eugene D. Nichols, Department of Mathematics Education. *Mathematics*. $6,460

Georgia

University of Georgia, Athens. Dr. Charles L. Koelsche, College of Education. *Biology, Earth Sciences, Physical Science*. (Classes to be held in Augusta.) $4,620

Shorter College, Rome. Professor Lewis Lipps, Department of Biology. *Biology, Earth Sciences*. $6,540

Hawaii

University of Hawaii, Honolulu 14. Dr. Michael M. Frodyma, Department of Chemistry. *Biology*. $3,610

Indiana

Indiana Central College, Indianapolis. Dr. Robert M. Brooker, Department of Chemistry. *General Science, Mathematics*. $5,990

Kansas

KANSAS STATE COLLEGE OF PITTSBURG, PITTSBURG. Professor Elton W. Cline, Department of Physical Science. *Biology, Physical Science*. $6,230

KANSAS STATE TEACHERS COLLEGE, EMPORIA. Professor Ted F. Andrews, Head, Department of Biology. *Biology*. $6,840

Kentucky

WESTERN KENTUCKY STATE COLLEGE, BOWLING GREEN. Dr. Tate C. Page, Chairman, Division of Education. *Chemistry, Physics*. $6,550

Mississippi

DELTA STATE COLLEGE, CLEVELAND. Dr. Eleanor Walters, Head, Department of Mathematics. *Mathematics*. (Classes to be held in Meridian.) $3,130

New York

AMERICAN MUSEUM OF NATURAL HISTORY-HAYDEN PLANETARIUM, NEW YORK 24. Dr. Franklyn M. Branley, Department of Astronomy. *Astronomy*. $2,730

SYRACUSE UNIVERSITY, SYRACUSE 10. Professor Robert B. Davis, Department of Mathematics. *Mathematics*. (Classes to be held in Scarsdale and Syracuse.) $6,000

North Carolina

SAINT AUGUSTINE'S COLLEGE, RALEIGH. Dr. Prezell R. Robinson, Academic Dean. *Mathematics*. $6,160

Ohio

UNIVERSITY OF TOLEDO, TOLEDO 6. Dr. Robert R. Buell, College of Education *Earth Science*. $6,000

Oklahoma

SOUTHEASTERN STATE COLLEGE, DURANT. Dr. Leslie A. Dwight, Head, Department of Mathematics. *Mathematics*. $5,230

Pennsylvania

MILLERSVILLE STATE COLLEGE, MILLERSVILLE. Professor William B. McIlwaine, Department of Science. *Biology, Physical Science*. $5,870

TEMPLE UNIVERSITY, PHILADELPHIA 22. Dr. Herman G. Kranzer, Department of Elementary Education. *Earth Sciences, Physical Science*. $6,140

Tennessee

KNOXVILLE COLLEGE, KNOXVILLE 21. Dr. Robert H. Harvey, Chairman, Department of Mathematics. *General Science*. $6,840

Texas

EAST TEXAS STATE COLLEGE, COMMERCE. Dr. Charles S. Rohrer, Department of Chemistry. *Earth Sciences, Physical Science*. $6,350

Virginia

BRIDGEWATER COLLEGE, BRIDGEWATER. Dr. Harry G. M. Jopson, Department of Biology. *Biology, Physical Science*. $6,000

A Bibliography of Doctoral Dissertations Completed in Elementary and Secondary Mathematics from 1950 to 1960*

Edward G. Summers and James E. Stochl
University of Minnesota, Minneapolis, Minnesota

The following bibliography consists of doctoral dissertations reported in *Dissertation Abstracts*, University Microfilms, Ann Arbor, Michigan, from 1951 through October 1960 relating to studies in mathematics on the elementary and secondary levels. The bibliography is considered to be comprehensive although there are some dissertations which do not appear in *Dissertation Abstracts*. The studies are organized under several topical headings to indicate the breadth of recent research. The intent is to inform the reader of the type of research being done without giving details. Further information about specific studies may be obtained from *Dissertation Abstracts* or the institution at which the study was completed.

TABULATION OF DOCTORAL DISSERTATIONS BY TOPIC

	Elementary	Secondary		Total
Research Compilations	3			3
History and Textbooks	6	5		11
Teacher Problems and Preparation		2		2
Teacher Competencies	4			4
Curriculum Development		11		11
Teaching Methods	17	14		31
Materials and Instructional Aids	7	2		9
Problem Solving and Understanding Concepts	12	9		21
Achievement	12	9		21
Enrichment-Remediation	3	3		6
Evaluation	4	4		8
Teacher Training			16	16
	68	59	16	143

ELEMENTARY

through grade six

Research Compilations

1. "An Analysis and Synthesis of Research Relating to Selected Areas in the Teaching of Arithmetic," Chester Enoch Bartram, 16'3, p. 2101. Ohio State University, 1956, Ph.D.
2. "The Implications of the Theory of Operationism and of Some Studies in Psychology and Anthropology for the Teaching of Arithmetic," William Carl Lowry, 18'1, p. 961. Ohio State University, 1957. Ph.D.
3. "The Relation Between Arithmetic Research and the Content of Elementary Arithmetic Textbooks," Sister Marie Constance Dooley, 20, No. 2, p. 562. University of Southern California, 1959. Ed.D.

* Second of a pair of articles. The first article in the series appeared in the May 1961 issue.

Arithmetic Textbooks

4. "A Survey of the Presentation of Certain Topics in Ten Series of Arithmetic Textbooks," Carl Mauro, 17'2, p. 1515. University of Maryland, 1957. Ed.D.
5. "An Analysis and Comparison of the Scope and Sequence of the Computational Programs in Selected Arithmetic Textbooks," Sumitra Bharqaua, 16'2, p. 1083. Syracuse University, 1956. Ph.D.
6. "An Investigation of the Verbal Matter in Recently Published Arithmetic Textbooks and Workbooks for the Intermediate Grades," Ralph Gott, 16'1, p. 477. University of Pittsburgh, 1955. Ed.D.
7. "An Analysis of Early American Arithmetic Textbooks Through 1810," Harold Ellsworth Barry, 18'2, p. 2049. University of Pittsburgh, 1958. Ph.D.
8. "An Historical Survey of the Developmental Treatment of Vulgar Fractions in American Arithmetics from 1719 to 1839," Emily Kathryn Jones, 18'1, p. 138, University of Pittsburgh, 1957. Ph.D.
9. "Quantitative Content in Elementary School Social Studies Textbooks," Gilbert M. Wilson, 19'3, p. 2816. George Peabody, 1959. Ed.D.

Materials and Instructional Aids

10. "An Evaluation of Non-Pencil-and-Paper Materials Prepared for Use in the Elementary School Arithmetic Program," William Charles Wolf, Jr., 20'2, p. 2170. The State University of Iowa, 1959. Ph.D.
11. "The Value of Multi-sensory Learning Aids in the Teaching of Arithmetical Skills and Problem Solving—an Experimental Study," Dana F. Swick, 20'3, p. 3669, Northwestern University, 1959. Ph.D.
12. "A Study of Manual Material in the Field of Arithmetic," Mary O'Hearn Folsom, 19'2, p. 1671. The State University of Iowa, 1958. Ph.D.
13. "A Topical Listing and Explanation of Selected Instructional Aids in Arithmetic," Bryce E. Adkins, 19'2, p. 1609. The State University of Iowa, 1958. Ph.D.
14. "The Use of Materials in the Teaching of Arithmetic," David Sole, 17'2, p. 1517. Colorado University, 1957. Ph.D.
15. "The Role of Instructional Aids in Arithmetic Education," William Patton Eidson, 16'3, p. 2095. The Ohio State University, 1956. Ph.D.
16. "The Use of Arithmetic Workbooks in Relation to Mental Abilities and Selected Achievement Levels," William Kirtley Durr, 15'3, p. 2126. University of Illinois, 1955. Ed.D.

Teaching Methods

17. "A Comparison of the Common Denominator Inversion Method in Teaching Division of Fractions," Lelon Roger Capps, 21 No. 4, p. 819, University of Minnesota, 1960. Ph.D.
18. "Introductory Teaching of Division" Arden Keim Ruddell, 14'3, p. 1645. Stanford University, 1954, Ed.D.
19. "A Study of Non-Pencil-and-Paper Method of Solving Arithmetical Word Problems Presented Visually," Olan Lee Petty, 12, p. 846, State University of Iowa, 1952, Ph.D.
20. "The Effect of Intra-Class Ability Grouping on Arithmetic Achievement in Grades Two Through Five," William Maurice Smith, 21 No. 3, p. 563. Louisiana State University, 1960. Ph.D.
21. "An Experimental Study Testing the Value of Using Multi-sensory Experiences in the Teaching of Measurement Units on the Fifth and Sixth Grade Level," Edward Raymond Mott, 20'2, p. 1678. Penn State University, 1959. Ed.D.
22. "The Effectiveness of Representative Materials and Additional Experience Situations in the Learning and Teaching of Fourth Grade Mathematics," Murray Macy, 17'1, p. 533. New York University, 1956. Ed.D.
23. "A Study of the Effectiveness of Specific Procedures for Solving Verbal Arithmetic Problems," Raymond Richard Hagelberg, 17'4, p. 2878. State University of Iowa, 1956, Ph.D.

24. "Use of Intensive Review as a Procedure in Teaching Arithmetic," Paul Clay Burns, 19'3, p. 3168. State University of Iowa, 1959. Ph.D.
25. "A Study of Some Basic Guiding Principles in Teaching Selected Aspects of Elementary Arithmetic with Implications for Educational Practice and Teacher Education in the Philippines," Carmen Balderrama Carlos, 19'3, p. 2860. Indiana University, 1958. Ed.D.
26. "The Notational System as an Aid to Understanding Arithmetic," Elbert W. Hamilton, 16'3, p. 1849. State University of Iowa, 1956, Ph.D.
27. "An Investigation into the Effectiveness of Two Methods of Instruction in Addition and Subtraction Facts," Morris Pincus, 16'2, p. 1415. New York University, 1956. Ph.D.
28. "A Comparison of the Effectiveness of Two Prescribed Methods of Teaching Multiplication of Whole Numbers," Craig Kerr Fullerton, 15'3, p. 2126. State University of Iowa, 1955. Ph.D.
29. "Three Methods of Teaching Basic Division Facts," Martha Norman, 15'3, p. 2134. State University of Iowa, 1955. Ph.D.
30. "A Developmental Approach to Teaching the Concept of Proof in Elementary and Secondary School Mathematics," Eugene Preston Smith, 20'3, p. 3668. Ohio State University, 1959. Ph.D.
31. "Intra-Class Grouping of Pupils for Instruction in Arithmetic in the Intermediate Grades of the Elementary School," Eugene Samuel Spence, 19'2, p. 1682, University of Pittsburgh, 1958. Ed.D.
32. "Effect of Social Climate on the Learning of Mathematics: the Effect Dominative and Integrative Classroom Climates Have on the Learning of Mathematics by 3rd Grade Elementary School Children," Fred Guggenheim, 21'5, p. 1125, New York University, 1960, Ph.D.
33. "Number Grouping as a Function of Complexity," Daniel Turnure Dawson, 13, p. 105, Stanford University, 1953, Ed.D.

Teacher Competencies

34. "Relationships Between Pupil Mean-Gain in Arithmetic and Certain Attributes of Teachers," Robert William Smail, 20'3, p. 3654. State University of South Dakota, 1959. Ed.D.
35. "The Professional Skill of Teachers on the Criterion of Problem Solving: Teachers of Arithmetic Grades Three Through Six," Richard Lee Turner, 20'4, p. 4591. University of Indiana, 1959. Ph.D.
36. "Critical Competencies for Elementary Teachers in Selected Curriculum Areas (Arithmetic, Reading, Social Studies)", Edith Peterson Merritt, 15'1, p. 377. Stanford University, 1955. Ed.D.
37. "The Effects of Teacher Attitudes Toward Learning Theories and Toward Children on Pupil Achievement in Fourth Grade Arithmetic and Reading," Philip Stanley Anderson, 16'1, p. 296. University of Minnesota, 1955. Ph.D.

Achievement

38. "An Experimental Study of Achievement in Arithmetic and the Time Allotted to Development of Meanings and Individual Pupil Practices," Donald Eugene Shipp, 19'1, p. 492. Louisiana State University, 1958. Ph.D.
39. "An Analysis of Arithmetic Achievement in Grades Four, Six and Eight," Carroll Ernest Rusch, 17'3, p. 2217. University of Wisconsin, 1957. Ph.D.
40. "Study of Third, Fourth, Fifth, and Sixth Grade Children's Preferences and Performances on Partition and Measurement Division Problems," Edwin Henry Hill, 12, p. 703. State University of Iowa, 1952. Ph.D.
41. "The Effect of Sixth Grade Pupils' Skill in Compound Subtraction When They Experience a New Procedure for Performing This Skill," Gail Edmund Cosgrove, 17'4, p. 2933. Boston University School of Education, 1957, Ed.D.
42. "A Study of Retention of Arithmetic Learning with Children of Low, Average, and High Intelligence at 127 Months of Age," John Felix Cheek, 20'1, p. 955, University of Wisconsin, 1959. Ph.D.
43. "The Effect of the Systematic Analysis of Errors on Achievement in the

Study of Fractions at the Sixth Grade Level," Orville Bendolph Aftreth. 14'1, p. 501, University of Minnesota, 1953, Ph.D.

44. "Comparison of the Reading, Arithmetic, and Spelling Achievement of Third and Fifth Grade Pupils in 1953 and 1934." Wendell Cuthbert Lanton, 14'3, p. 1619. Northwestern University, 1954. Ph.D.
45. "A Study of Efficiency of Learning and Retention in Arithmetic Among Children of Low, Average, and High Intelligence at a Mean Age of 112 Months," John Frederick Feldhusen, 19'2, p. 1651. University of Wisconsin, 1958. Ph.D.
46. "Sibling Resemblance in Reading and Arithmetic Growth," Barbara Jane Neary Borusch, 19'2, p. 1288. University of Michigan, 1958. Ph.D.
47. "The Relationship Between Personality and Academic Achievement (Reading and Arithmetic) of Seven-Year-Olds," Cleo Dorris Carter, 19'2, p. 1027, Indiana University, 1958, Ed.D.
48. "Effects of Different Types of Kindergarten Programs Upon Reading and Arithmetic Readiness," Melvin Linder Miller, 19'2, p. 2029. University of Illinois, 1958, Ed.D.
49. "An Investigation of the Learning of the Three Cases of Percentage in Arithmetic," Clyde Raymond Montgomery 19'2, p. 1676. State University of Iowa, 1958. Ph.D.

Problem Solving and Understanding Concepts

50. "A Study in Mental Arithmetic: Proficiency and Thought Processes of Pupils Solving Subtraction Examples," Betty Irene Brown, 17'3, p. 2219. University of Pittsburgh, 1957. Ph.D.
51. "Number Rearrangement as Arithmetical Learning," Robert Keith Woods, 14'2, p. 955. State University of Iowa, 1954. Ph.D.
52. "The Relationship of Selected Factors to the Ability to Solve Problems in Arithmetic," Vincent Eugene Alexander, 29'2, p. 1221. University of Southern California, 1959, Ed.D.
53. "The Effects of Initial Group Experience upon Subsequent Individual Ability to Solve Arithmetic Problems," Bryce Byrne Hudgins, 19'3, p. 2851. Washington University, 1958, Ph.D.
54. "A Study of Certain Factors Affecting the Understanding of Verbal Problems in Arithmetic," Richard Post, 19'1, p. 90. Colorado University, 1958, Ph.D.
55. "Identification and Measurement of the Arithmetical Concepts and Abilities of Kindergarten, First, and Second Grade Children," Clayton Lee Carpenter, 17'3, p. 2205, University of Nebraska Teachers College, 1957, Ed.D.
56. "A Study of the Relation Between Children's Understanding of Computational Skills and Their Ability to Solve Verbal Problems in Arithmetic," Charles Chauncey Butler, 16'3, p. 2400. Boston University School of Education, 1956. Ed.D.
57. "A Study of the Arithmetic Concepts Possessed by the Pre-school Child at the Time of Entrance into Kindergarten," Corwin E. Bjonerud, 18'2, p. 1314. Wayne State University, 1957, Ed.D.
58. "Children's Methods of Problem Solving in Arithmetic," Richard Stanley Leno, 19'3, p. 2549. Stanford University, 1958, Ed.D.
59. "An Investigation of the Degree of Understanding of Meanings in Arithmetic of Pupils in Selected Elementary Schools," David Rappaport, 18'2, p. 1322. Northwestern University 1957. Ed.D.
60. "Children's Interests and the Content of Problems in Arithmetic," Kenneth Cover Hensell, 16'3, p. 1857. Stanford University, 1956. Ed.D.
61. "An Analysis of Sixth Grade Pupils' Thinking Regarding Their Solution of Certain Verbal Arithmetic Problems," Frances Pauline Miller, 21 No. 3, p. 503. Indiana University, 1960. Ph.D.

Enrichment

62. "An Arithmetic Program for the Superior Student," William Harold Mullins, 20'4, p. 4002. State University of Iowa, 1958. Ph.D.

63. "The Effects of a Summer Camp Enrichment Program in Arithmetic," Forrest Furman Evans, 18'1, p. 163. George Peabody College for Teachers, 1957. Ed.D.
64. "A Study of an Enrichment Program in Arithmetic for Children in the Fourth Grade," Floreine Herron Hudson, 18'1, p. 958. Alabama Polytechnic Institute, 1957, Ed.D.

Evaluation

65. "The Development and Evaluation of a Non-computational Mathematics Test for Grades Five and Six," Calhoun Crofford Collier, 17'2, p. 1027. Ohio State University, 1956, Ph.D.
66. "A Study of the Effectiveness of an Oral Arithmetic Program Prepared for Use at the Intermediate Grade Level," Mary Frances Flournoy, 13, p. 731. State University of Iowa, 1953, Ph.D.
67. "A Composition of Objectives, Methods, and Achievement in Arithmetic in the United States and in the Netherlands," Klaas Kramer, 17'4, p. 2881. State University of Iowa, 1957. Ph.D.
68. "The Construction and Revision of an Arithmetic Vocabulary Test for Grades Four, Five, and Six," John Herbert Lawson, 19'3, p. 3246, Boston University School of Education, 1959. Ed.D.

SECONDARY

History and Textbooks

1. "An Analysis of the Plane Geometry Content of Geometry Textbooks Published in the United States Before 1900," John Donald Wilson, 20'2, p. 1648. University of Pittsburgh 1959, Ed.D.
2. "An Analysis of Early Algebra Textbooks Used in the American Secondary Schools Before 1900," Angie Turner King, 15'2, p. 746. University of Pittsburgh, 1955, Ph.D.
3. "A History of the Purposes, Content, and Grade Placement of Business Arithmetic in General Education in the United States Since 1890," Frank Saidel, 13, p. 58. Colorado University, 1952, Ph.D.
4. "A History of the Use of Certain Types of Graphical Representation in Mathematics Education in the Secondary Schools of the United States," Joseph Anthony Izzo, 17'2, p. 1506. Colorado University 1957. Ph.D.
5. "A Study of Some Concepts in Algebra as Used by Writers of High School Textbooks," Nageswari Rajaratnam, 18'1, p. 532. University of Illinois, 1957. Ph.D.

Materials

6. "Reading Eighth Grade Mathematical Materials for Selected Purposes," Vernon Earl Troxel, 20'1, p. 168. University of Illinois, 1959. Ed.D.
7. "An Evaluation of a Technique to Improve Space Perception Abilities Through the Construction of Models by Students in a Course in Solid Geometry," Louis Cohen, 21'5, p. 1136, Yeshiva University, 1959, Ph.D.

Curriculum Development

8. "Practices and Trends in the Teaching of Secondary School Mathematics," Luther Leroy Shetler, 19'2, p. 2033. Indiana University, 1958. Ed.D.
9. "The Establishment of Integrated Algebra-Geometry Courses in the Secondary Schools of California," Robert Clay McLean, Jr., 21, No. 1, p. 135. University of Southern California, 1960. Ed.D.
10. "Mathematics Instruction in Iowa High Schools," Ross Allan Nielson, 15'3, p. 2490, State University of Iowa, 1955, Ph.D.
11. "A Recommended Program for High School General Mathematics as Determined by an Appraisal of Present Content and Placement of Subject Matter," Lois Tyler Wales, 19'1, p. 745. Louisiana State University, 1958, Ph.D.
12. "A New Basis of Organization for the Junior High School Mathematics Program," William Lee Carter, 17'4, p. 2521. Ohio State University, 1952. Ph.D.

13. "School Policy in Student Choices of Courses in High School Mathematics," Daniel Smith Parkinson, 20'1, p. 927. University of Wisconsin, 1959. Ph.D.
14. "The Attitudes of Pennsylvania Secondary Mathematics Teachers Toward the Inclusion of Analytic Geometry, Calculus, and Statistics in the High School Program," Daniel Paul Spillane, 20'2, p. 1646. University of Pittsburgh, 1959. Ed.D.
15. "The Development of a Procedure for Study and Revision of the Mathematics Curriculum in Secondary Schools," Lester R. Van Deventer, 14'2, p. 800. University of Illinois, 1954. Ed.D.
16. "The Development of an Instrument to Predict Success in Analytic Geometry of Entering College Freshmen in Engineering and the Indication of Some Possible Improvements Advisable in their Secondary School Mathematics Courses," Frances Ellura Knights, 18'1, p. 120, Pennsylvania State University, 1957, Ed.D.
17. "The Application of Elementary Statistics in Analysis of Data by Selected Secondary School Students," Charles Martin Bridges, Jr., 20'2, p. 1223. University of Tennessee, 1959. Ed.D.
18. "The Mathematics Program of the Soviet Secondary School: Its Status and Innovations," Bruce Ramon Vogeli, 21, No. 2, p. 305. University of Michigan, 1960. Ph.D.

Teacher Problems and Preparation

19. "Preparation, Problems, and Practices of Mathematics Teachers in the North Central High Schools of Oklahoma," Vivian Nemececk, 16'1, p. 73. University of Oklahoma, 1955. Ed.D.
20. "Enrollment Characteristics and Teacher Preparation in Michigan Secondary School Mathematics," Arvo Ephraim Lohela, 19'1, p. 471. University of Michigan, 1958, Ph.D.

Teaching Methods

21. "A Study on Course Content and Teaching Methods of Bookkeeping in Secondary Schools," Winifred J. Wagoner, 14'3, p. 2299. State University of Iowa, 1954. Ph.D.
22. "A Comparison of the Effectiveness of the *Power of Ten* and *Same Decimal Unit* Methods as Applied to Introductory Work in the Division of Decimals," Jerry Neal Kuhn, 14'3, p. 1644. State University of Iowa, 1954, Ph.D.
23. "The Combination of the Guess-and-Check and Multi-Equation Methods for Deriving the Equations for Verbal Problems in Elementary Algebra," Herbert Francis Miller, 20'2, p. 2180. Ohio State University, 1959. Ph.D.
24. "The Relative Merits of Teaching Plane Geometry with Varying Amounts of Applications," Edward Joseph Zoll, 18'1, p. 971. New York University, 1957. Ed.D.
25. "Discovering in Geometry through the Process of Variation: Generation of New Theorems and Exercises in Geometry by Performing Certain Operations upon Either the Data or the Conclusion, or Both, of a Known Theorem or Exercise," Clarence Henry Heinke, 18'1, p. 886, The Ohio State University, 1953, Ph.D.
26. "Comparison of Two Approaches to the Teaching of Selected Topics in Plane Geometry," Eugene Douglas Nichols, 16'3, p. 2106. University of Illinois, 1956. Ph.D.
27. "The Effect of Certain Teaching Practices Involving Systematic Home-School Cooperation upon the Achievement of Eighth Grade Pupils in Mathematics," Louie B. Ilioff, 17'4, p. 2935. Pennsylvania State University, 1957, Ed.D.
28. "A Comparison of Two Methods of Teaching Certain Topics in Ninth Grade Algebra," Max A. Sobel, 14'3, p. 1647, Colorado State, 1954. Ph.D.
29. "Techniques, Methods, Procedures and Provisions Used in Selected Maryland Public Schools in Teaching Mathematics to Rapid Learners," Major Boyd Jones, 20'3, p. 3663. Cornell University, 1959. Ph.D.

30. "Factors Present in Effective Teaching of Secondary School Mathematics," Theodora Sophia Nelson, 20'3, p. 3207. University of Nebraska Teachers College, 1959, Ed.D.
31. "The Relative Effectiveness of Teaching First Year Algebra by Television-Correspondence Study and Teaching First Year Algebra by Conventional Methods," David Wayne Wells, 20'3, p. 3137. University of Nebraska Teachers College, 1959, Ed.D.
32. "The Nature of Mathematical Evidence and Its Significance for the Teaching of Secondary School Mathematics," Elizabeth Beaman Hesch, 16'1, p. 507. Colorado University, 1955. Ph.D.
33. "A Comparative Study of Two Grouping Procedures in the Junior High School on Measures of Ability and Achievement in Mathematics and English," Mildred Emily Sommers, 21'5, p. 1115, Michigan State University, 1960, Ed.D.
34. "A Comparison of the Postulational Approach and the Traditional Approach in Teaching Selected Topics in Algebra to Above Average Students," Samuel Louis Greitser, 21'5, p. 1137, Yeshiva University, 1959, Ph.D.

Achievement

35. "An Analysis of Certain Components of Mathematical Ability, and an Attempt to Predict Mathematical Achievement in a Specific Situation," Ralph H. Coleman, 16'3, p. 2062. Indiana University, 1956. Ph.D.
36. "The Effect of an Experimental Course in Geometry on Ability to Visualize in Three Dimensions," Francis Robert Brown, 15'1, p. 83. University of Illinois, 1954. Ed.D.
37. "Adequacy of Related Technical Instruction in Vocational Trade and Industrial Education in Teaching Principles of Mathematics and Physical Science," Byrl Raymond Shoemaker, 17'2, p. 1517. Ohio State University, 1957. Ph.D.
38. "An Analysis of the Outcomes of Functional Mathematics and Formal Mathematics as Measured by Certain Objective Tests After Completion by the Students of Two Years of Study," William Jack Bush, 20'1, p. 920. University of Arkansas, 1959. Ed.D.
39. "Efficiency in First Year Algebra," Philip Peak, 15'2, p. 1574. Indiana University, 1955. Ph.D.
40. "An Analytical Study of Achievement in Grade Eight General Science and in Grade Eight General Mathematics in Minnesota Public Schools," George James McCutcheon, 18'2, p. 1306. University of Minnesota, 1957. Ph.D.
41. "The Effect of Reading Instruction upon Achievement in Seventh Grade Arithmetic," John Foster Curry, 15'3, p. 2059. Indiana University, 1955. Ed.D.
42. "An Investigation of the Relationships Between Pupil Achievement in First Year Algebra and Some Teacher Characteristics," Hugh Joseph McCardle, 20'1, p. 165. University of Minnesota, 1959. Ph.D.
43. "Relationships Between Instructional Provisions and Functional Competence in mathematics of Iowa High School Seniors," John W. Renner, 15'2, p. 1188. State University of Iowa, 1955. Ph.D.

Problem Solving and Understanding Concepts

44. "The Relative Effects of Variations in Pure and Physical Approaches to the Teaching of Euclidean Geometry on Pupils' Problem Solving Ability," Theodore E. Kellogg, 16'3, p. 2404. University of Minnesota, 1956. Ph.D.
45. "A Concept Approach to the Teaching of Algebra," Lewis Edwin Hirschi, 17'1, p. 778. University of Utah, 1956. Ed.D.
46. "The Achievement in Mathematics and Science of Ninth Grade Pupils in the Schools of Indiana," Rolla Francis Pruett, 21 No. 3, p. 505. Indiana University, 1960, Ed.D.
47. "The Peabody Public School Summer High School Program for Academically Talented Students in Mathematics and Science," Milton Lewis Ferguson, 21, No. 3, p. 560, George Peabody College for Teachers, 1960. Ed.D.

48. "The Role of Algebra in the Development of Relational Thinking," William Nichols Jackson, 17'4, p. 2936. Ohio State University, 1952. Ph.D.
49. "The Role of Maturity in Acquiring a Concept of Limit in Mathematics," Lehi Tingen Smith, 20'2, p. 1288. Stanford University, 1959. Ed.D.
50. "Abstraction and Concept Formation in the Field of Secondary School Mathematics," Karmi Friede, 14'2, p. 1347. Colorado University, 1954. Ph.D.
51. "Theoretical Topics in Mathematics at the Eighth Grade Level," John Arthur Brown, 17'3, middle section of volume under "Education—Teacher Training," University of Wisconsin, 1957. Ph.D.
52. "Relationship Between Selected Factors and Achievements in a Unit on Probability and Statistics for Twelfth Grade Students," James Ernest McKinley, 21, No. 3, p. 561, University of Pittsburgh, 1960, Ed.D.

Enrichment—Remediation

53. "Enrichment Topics for First and Second Course Algebra for Bright Pupils," Joseph Neal Payne, 15'3, p. 2491. University of Virginia, 1955. Ph.D.
54. "A Comparative Study of the Effects of an Enriched Program for the Talented in Advanced Algebra Classes," Roy Gilbert Long, 18'1, p. 529. Indiana University, 1957. Ed.D.
55. "A Study of Remedial Arithmetic Conducted with Ninth Grade Students," Allen L. Bernstein, 15'2, p. 1567. Wayne University, 1955. Ed.D.

Evaluation

56. "Some Influences of Evaluations on the Science and Mathematics Program in Oregon Secondary Schools," Clarence Edward Diebel, 19'3, p. 2266. University of Oregon, 1959. Ed.D.
57. "An Analysis of the Evolving Evaluation Program in Elementary Geometry," Blanche Crisp Badger, 17'1, p. 571. George Peabody College for Teachers, 1956, Ph.D.
58. "The Nature of Definition in High School Geometry, A Critique of Current Practices," Sheldon Stephen Myers, 16'1, p. 716. Ohio State University, 1955. Ph.D.
59. "The Design of an Observational Instrument for the Description of the Algebra Classroom in the Light of Selected Aims—Indexed by Behavior of Secondary School Mathematics Teaching," Elisabeth Muriel Jane Ferguson, 17'3, p. 2220. Washington University, 1957. Ph.D.

COLLEGE TEACHER TRAINING

1. "Teacher Preparation for Elementary School Arithmetic," Gerald William Brown, 14'3, p. 1627. Stanford University, 1954. Ed.D.
2. "Opinions of Secondary Mathematics Teachers Concerning the Fifth Year of Teacher Education," Dwain E. Small, 15'3, p. 2120. Indiana University, 1955. Ed.D.
3. "The Relationship Between Achievement in Elementary Arithmetic and Vocabulary Knowledge of Elementary Mathematics as Possessed by Prospective Elementary Teachers," Clarence Alois Phillips, 20'2, p. 1687. University of Illinois, 1959. Ed.D.
4. "A General Studies Curriculum in Science and Mathematics for College of Education in Oregon," Ralph Emerson Badgley, 19'1, p. 69. University of Colorado, 1956. Ed.D.
5. "The Arithmetical Understandings of Elementary School Teachers," John Ellis Bean, 19'1, p. 708. Stanford University, 1958. Ed.D.
6. "A Study of Selected Data Relative to the Education of Texas Teachers of Secondary School Mathematics in Order to Suggest a Program for Their Future Education," Sister Mary Matthew Donovan, 16'2, p. 1228. University of Houston, 1956. Ed.D.
7. "A Study of the Mathematical Backgrounds of Students Who Are Preparing to Be Elementary Teachers and Who Are Enrolled in Certain Colleges in

Minnesota," Ethel Louise Curtis, 16'3, p. 2391. University of Minnesota, 1955. Ph.D.

8. "The Development and Appraisal of a Course in Basic Mathematics for Prospective Elementary School Teachers," Joseph Jean Stipanowich, 17'4, p. 2531. Northwestern University, 1956. Ed.D.
9. "Preparation of Mathematics Teachers for Public Two-Year Colleges in New York State: A Study of Selected Factors in the Education Programs of Public Two-Year Colleges in New York State that Relate to the Pre-Service Preparation of Mathematics Teachers for These Colleges," Charles Wesley Laffin, Jr., 20'4, p. 4341. New York University, 1959. Ed.D.
10. "A Study of the Effectiveness of the Subject Matter of Modern Mathematics in the Preparation of Elementary School Teachers," Lyman Coleman Knight, 19'2, p. 1299. University of Pittsburgh, 1958. Ed.D.
11. "Levels of Arithmetical Achievement, Attitudes toward Arithmetic, and Problem Solving Behavior Shown by Prospective Elementary Teachers," John Robert O'Donnell, 19'2, p. 1300. Pennsylvania State University, 1958. Ed.D.
12. "A Program in Mathematics Education for West Virginia Teachers of Secondary Mathematics," Alphonso Joseph DiPietro, 17'1, p. 569. George Peabody College for Teachers, 1956. Ph.D.
13. "A Comparison of Two Curriculums for the Preparation of Teachers of Mathematics in Secondary Schools and of the Students Trained under Each," Edmund Cole Osborne, 16'2, p. 1409. Boston University School of Education, 1956. Ed.D.
14. "The Preparation of College Mathematics Instructors," Lyman Colt Peck, 19'2, p. 1666. Ohio State University, 1953. Ph.D.
15. "Growth of Elementary School Teachers in Arithmetical Understandings through In-Service Procedures," Lonie Edgar Rudd, 18'1, p. 947. Ohio State University, 1957. Ph.D.
16. "An Analysis of Two Mathematics Workshops for Teachers and Outcomes as Reflected in Participating Schools," Roscoe Douglas Kelley, 19'2, p. 1305. Albama Polytechnic Institute, 1958. Ed.D.

LUNG CANCER TISSUE GROWN IN TEST TUBE

Lung cancer can be studied in the laboratory under controlled conditions for the first time.

Dr. Relda Cailleau of the Cancer Research Institute, University of California Medical Center here, has grown lung cancer cells in test tubes. Scientists can, therefore, now study the specific physical and chemical behavior of human lung cancer.

Dr. Cailleau has found that the cancer cells have an abnormal number of chromosomes, averaging 79 chromosomes instead of the 46 normally found in tissue cells.

Chromosomes are the hair-like fibers appearing in the nucleus of a cell when it divides or reproduces and containing the genes that control inherited characteristics.

The cancerous tissue, removed from a human lung in January, 1959, was first grown in covered dishes. Part of the tissue, containing 200 to 300 cancer cells, was later placed in a special flask and filled with a nourishing liquid.

After about a month, the cells suddenly began to multiply. Since then, Dr. Cailleau has been transferring some of the still-malignant cells to a new flask every two weeks for further study.

Although many kinds of cells are being grown in laboratory flasks, cultures of human lung cancer are extremely rare. One reason is that it is difficult to tell whether the cells that finally grow are cancer tissue cells or normal cells that are often mixed in with them.

IN MEMORIAM

Ray C. Soliday

It is with deep regret that the Board of Directors of the CASMT announce to the subscribers of School Science and Mathematics the death of Ray C. Soliday, our former Business Manager and Treasurer. Mr. Soliday passed away at 8:00 a.m., May 6, 1961, following a heart operation at the Mayo Clinic, Rochester, Minnesota.

As most CASMT members are aware, Ray retired as Business Manager last summer, after 18 years of service to the Association. The December 1960 issue of the journal, which was dedicated to Ray and Eleanor Soliday in tribute to their years of service to the organization, carried an account of the lives of the Solidays.

The Elementary School Science Library for 1960

Paul E. Kambly and Winifred Ladley
School of Education, University of Oregon, Eugene, Oregon

This is the seventeenth yearly list of books for elementary school science compiled and published in SCHOOL SCIENCE AND MATHEMATICS. The purpose, like that of preceding lists, is to suggest to elementary school teachers books that are supplementary to basic text series either for their values as sources of information or for recreational reading. Certain books included primarily because of assumed value as recreational reading are below desired standards of good sources of science information. The sub-division topics are of no significance except as an aid in grouping the books.

Exact grade placement is difficult because of variations in pupil reading ability as well as in different uses made of the books. The lowest grade levels for pupils' use are indicated.

Books for Elementary School Science[1]

Ancient Animals

	Grade	Price
Discovering Dinosaurs. By Glenn O. Blough. 48 pp. '60. Whittlesey Describes dinosaurs, their size and living habits. Also explains how paleontologists use fossils to gather information about these animals.	3	$2.50
Sixty Million Years of Horses. By Lois and Louis Darling. 64 pp. '60. Morrow. Numerous illustrations including charts and diagrams add interest to this simple description of present day breeds of horses, their evolution from eohippus and the part they have played in the lives of people. No index.	3	2.50

Animals

(See also list of books on birds and insects)

	Grade	Price
A Book of Tongues. By Anne Walsh Guy. 48 pp. '60. Steck. Though appearing to be primarily a picture book, a surprising amount of information of different types of tongues such as that of the lemur, the chameleon, the snail, the bee, the hummingbird, the snake, the ant-eater, is contained in a book that younger children will enjoy even though they cannot read the text.	1	1.75
A Dog for Susie. By Ruth Nordlie. 64 pp. '60. Children's Press. Primarily recreational reading that could be used by kindergarten or first grade children interested in "Pets." Attractively illustrated including captioned pictures of various kinds of dogs. Charming story, large well-spaced type.	1	2.50
The Jack Rabbit. By M. Vere DeVault. 30 pp. '59. Steck. Includes information about different kinds of rabbits, their economic importance, protective coloration and the place of rabbits in a "food pyramid." Short sentences, well-chosen words and pronunciations where necessary make this an easy-to-read from grade 2 on.	1	1.75

[1] Publishers and their addresses are listed at the end of this section.

	Grade	Price
Box Turtle Lives in Armor. By Charles Paul May. 48 pp. '60. Whittlesey..........	2	$2.50
Written in story form with attractive illustrations. Includes information about lizards, snakes, and amphibians as well as turtles. A useful feature is appended: "How to keep a Turtle for a Pet."		
Frogs and Toads. By Charles A. Schoenknecht. 32 pp. '60. Follett.	2	1.08
The kinds of frogs and toads, their habitats and life histories. Colored illustrations help make this a very attractive and informative book. A "Beginning Science Book."		
Shag.—Last of the Plains Buffalo. By Robert McClung. 96 pp. '60. Morrow..........	3	2.95
Habits and behavior, growth and development, natural and human enemies of the buffalo are described in a well-illustrated narrative depicting the life of one buffalo bull from birth until it becomes leader of the herd that survives the slaughter by buffalo hunters.		
The Tall Grass Zoo. By Winifred and Cecil Lubell. 30 pp. '60. Rand	3	2.75
The small creatures that are found in your own back yard, described in informative, delightful style. Includes insects, spiders, earthworms, snails and amphibians. Many colorful pictures enhance the well-written, rhythmical text.		
The Bear Family. By George F. Mason. 96 pp. '60. Morrow.....	4	2.75
The appearance, habitat and behavior of the American black bear, the grizzly bear, the Alaska brown bear, the ploar bear and bears in other countries. Drawings in black and white.		
Water Mammals. By Alexander Seidel. 28 pp. '60. Maxton.......	4	1.38
Illustrations with accompanying text describing animals, such as seals, otters, beavers, muskrats, whales, porpoises, dolphins and polar bears.		
All About Fish. By Carl Burger. 140 pp. '60. Random..........	5	1.95
In addition to descriptions and illustrations (not actual color) of many fresh-water and salt-water fish, there are chapters on "Fish as Pets" and "Fishing for Fun," "Suggestions for Further Reading" and an index.		
Animal Clocks and Compasses. By Margaret O. Hyde. 157 pp. '60. Whittlesey..........	5	2.95
Fascinating stories of the migration of animals emphasizing their ability to recognize the time to act and the direction in which to move. Excellent chapter on "Science Projects," a good bibliography and competent index.		
The Story of Spiders. By Dorothy Edwards Shuttlesworth. 55 pp. '59. Garden City Books..........	5	2.95
Varieties and characteristics of spiders discussed with a view to clearing-up misconceptions. Excellent colored drawings add greatly, especially to descriptions of kinds of webs and their uses.		

Astronomy

The Moon Seems to Change. By Franklyn M. Branley. 36 pp. '60. Crowell..........	1	2.35
An excellent simple but accurate explanation of why the moon seems to change in shape. Large drawings in black, white, orange, and green and simple text make this an exceptional supplementary science book for young children.		
Space. By Marian Tellander. 32 pp. '60. Follett..........	2	1.08
A beginner's book on astronomy which provides basic informa-		

	Grade	Price
tion about the solar systems. Colored illustrations help make this an attractive book. A "Beginning Science Book."		
All About the Planets. By Patricia Lauber. 140 pp. '60. Random.. Descriptions of each of the planets and their satellites. What we know about conditions on these planets and the possibility of their being inhabited by living things. Illustrations include diagrams and charts. Indexed.	5	$1.95
The Sky Is Our Window. By Terry Maloney. 128 pp. '60. Sterling. A source book for advanced sixth grade pupils. Diagrams, charts, and photographs, some in color, clarify the text which explains the solar system and other features of the universe. Glossary and index.	6	3.95
The Stars for Sam. By W. Maxwell Reed. Rev. ed. Ed. By Paul F. Brandwein. 179 pp. '60. Harcourt.......................... Reset, redesigned and copiously illustrated with new photographs, this edition of a book first published in 1931 has been thoroughly revised to include fresh material based on recent research. Well-indexed.	6	4.50
Biography		
George Westinghouse. By Henry Thomas. 128 pp. '60. Putnam.... A simple biography of Westinghouse who received his first patent at the age of nineteen and then went on to develop the air brake and later to bring cheap electric power to the people.	4	2.50
Break Through in Science. By Isaac Asimov. 197 pp. '60. Houghton The history of some of man's greatest discoveries. There is a chapter devoted to each of twenty-six men including names such as Archimedes, Copernicus, Newton, Bessemer, Jenner, Edison, Einstein, and Carver.	5	4.00
Gregor Mendel: Father of the Science of Genetics. By Harry Sootin. 223 pp. '60. Vanguard.................................... An interesting biography that will hold the attention of young people. Mendel's famous experiments with garden peas are explained in simple terms. Bibliography and index.	5	3.00
Pioneers of Science. By Harry Sootin. 254 pp. '60. Vanguard..... The stories of 12 scientists who were pioneers in different fields: Pascal, Scheele, Volta, Davy, Henry, Darwin, Adams, Metchnekoff, Hertz, Du Bois, Langley, and Bequerel. Good table of contents and bibliography. No index.	5	3.00
Scientists Behind the Inventors. By Roger Burlingame. 192 pp. '60. Harcourt.. Readable, stimulating accounts of scientists whose discoveries have made inventions possible. Included are Joseph Black, Benjamin Silliman, Joseph Henry, Louis Pasteur, Michael Pupin, Marie and Pierre Curie, and Albert Einstein. Good differentiation between discovery and invention, showing interaction of pure and applied science.	6	3.25
Birds		
What Is a Bird? By Gene Darby. 48 pp. '60. Benefic............ Primer-style text, illustrations, many of which are in color, explain the physical characteristics, nesting habits, and migration of birds. Read-it-yourself level may be Grade 2, but working is nearer Grade 1.	1	1.60
Hummingbirds. By Betty John. 32 pp. '60. Follett............. Attractive illustrations and simple text make this an excellent source of infomation about hummingbirds. A "Beginning Science Book."	2	1.08

	Grade	Price
Ground Birds. By Charles L. Repper. 64 pp. '60. Morrow........ Characteristics and living habits of the woodcock, ovenbird, road runner, burrowing owl, snow bunting, whippoorwill, and bob-white. Illustrated with excellent black-and-white drawings. No index or table of contents. Type large and well-spaced.	3	$2.50
Ducks, Geese and Swans. By Herbert Wong. 65 pp. '60. Lane...... A well illustrated Sunset Junior Book. Includes maps showing flyways, wintering and summering areas and refuges. Indexed.	4	2.95

Conservation

	Grade	Price
Our Friend the Forest, a Conservation Story. By Anne Marie Jauss. 61 pp. '59. Doubleday.................................. Short sentences, attractive black-and-white drawings give special usefulness to this simply written book, explaining the interdependence of plants and animals and the importance of forests to man.	3	2.00
Saving Wildlife for Tomorrow. By Solveig Paulson Russell. 32 pp. '60. Melmont.. A beginner's book on wildlife conservation. Illustrations add little to the text which explains very simply how soil and water conservation practices help provide homes for wildlife. Brief bibliography, no index.	4	1.88
Exploring the River. By John and Jane Greverus Perry. 203 pp. '60. Whittlesey.. An excellent book for material on conservation. The importance of water, floods, soil conservation and pollution problems are some of the topics discussed as the authors take you exploring along "Our River." Excellent line drawings, good index.	5	3.50

General Nature Study

	Grade	Price
New Worlds Through the Microscope. By Robert Disraeli. 175 pp. '60. Viking.. A revision of the author's *Seeing the Unseen* first published in 1939. Excellent photomicrographs of insects, algae, fungi, pollen, seeds, crystals, and cloth with equally well written text make this a very desirable supplementary book for students interested in microscopic objects. No index.	4	4.00
Tale of a Pond. By Henry Kane. 121 pp. '60. Knopf............ Similar to the author's *Wild World Tales.* Explains the living habits and life cycles of plants and animals that inhabit a pond. Photographs enhance the text.	4	3.00
Under a Green Roof. By Anne Marie Jauss. 64 pp. '60. Lippincott. Very readable account of some of the characteristics of animals, including birds, that live in the forests of Alaska, the Southwest, Puerto Rico, the Pacific coast and the swamps of the South. Illustrated with black-and-white drawings. No table of contents or index.	4	2.95
Meadows in the Sea. By Alida Malkus. 72 pp. '60. World........ Descriptions of microscopic plants and animal life that live in the sea. Information about their importance in food chains. Black-and-white diagrams and drawings except for two double page spreads in color. Indexed for scientific as well as common names and for illustrations.	5	2.75
Science on the Shores and Banks. By Elizabeth K. Cooper. 187 pp. '60. Harcourt.. Descriptions of various kinds of fresh-water and salt-water plant and animal life with specific directions for collecting and experi-	5	3.25

	Grade	Price
menting with them. Useful equipment and scientific methods are suggested.		
Under the Sea. By Maurice Burton. 256 pp. '60. Watts.......... Divided into five parts: How it all began; How it goes on; Who lives there; Zones of the sea; How we know. Illustrations in color. Includes glossary and index.	6	$4.95

General Science

	Grade	Price
Lights. By Margaret C. Farquhar. 48 pp. '60. Holt............. "A book to begin on" story of light from the days before man appeared on the earth to modern times. Text and colorful drawings show the procession of lighting devices that man has developed.	1	2.50
Air All Around. By Tillie S. Pine and Joseph Levine. 48 pp. '60. Whittlesey.. Beginner's information about the atmosphere, compressed air, burning, circulation of air, and flight in air. Many drawings, simple experiments, no index.	2	2.50
Friction All Around. By Tillie S. Pine and Joseph Levine. 48 pp. '60. Whittlesey.. Explanation in simple terms, easy-to-do experiments and many drawings of what friction is and what it does. Some consideration given to static electricity. Similar in style to the authors' "Air All Around."	2	2.50
From Rocks to Rockets. By Solveig Paulson Russell. 30 pp. '60. Rand The title does not indicate that this is the story of the development of simple tools from prehistoric man to the present. There is no information about rockets. Attractive format—large print, appealingly simple illustrations—but no table of contents or index.	2	2.75
Things That Spin. From Tops to Atoms. By Irving and Ruth Adler. 48 pp. '60. Day.. Six important facts about spinning tops are first explained with the help of diagrams, charts, and drawings. These facts are then used to explain the forces involved in riding a bicycle, in keeping an airplane level by an automatic pilot, etc. Brief word list but no index.	2	2.00
Hurricanes, Tornadoes, and Blizzards. By Kathryn Hitte. 82 pp. '60 Random.. A very well illustrated discussion of air movements and the storms they create, including an explanation of how the weatherman is sometimes able to warn people of approaching storms. Indexed.	3	1.95
Let's Go to a Rubber Plant. By Marilyn Wilson. 48 pp. '60. Putnam An excellent substitute for a field trip through a rubber plant where children see the production of a tire from the raw rubber to a finished tire. Well illustrated with line drawings. Glossary.	3	1.95
Rocks and the World Around You. By Elizabeth Clemons. 109 pp. '60. Coward-McCann........................... A beginner's book on rock collecting. Illustrated with black-and-white drawings. Includes instructions for keeping records and the steps to take in identifying rocks. Good list of "Other Books to Read." Adequate index.	3	3.50
The How and Why Wonder Book of Beginning Science. By Jerome J. Notkin and Sidney Gulkin. 48 pp. '60. Grosset............ Deals with areas of science such as light, weather, plants, machines and electricity. Primarily a book of suggestions for demon-	3	1.00

	Grade	Price
strations and experiments. Drawings in color and black-and-white.		
The How and Why Wonder Book of Our Earth. By Felix Sutton. 48 pp. '60. Grosset	3	$1.00
A beginner's book on geology. Answers questions about how the earth was formed and many of its characteristics. Drawings in color and black-and-white.		
The How and Why Book of Weather. By George Bonsall. 48 pp. '60. Grosset	3	1.00
Answers many questions about different types of weather. Numerous suggestions for performing simple experiments that will help children understand the text. Drawings in color and black-and-white.		
The Story of the Atom. By Mae and Ira Freeman. 82 pp. '60. Random	3	1.95
An excellent explanation of the structure of matter and how it is possible to split atoms. Written in simple language and illustrated with large and helpful drawings. Glossary and index.		
Drums, Rattles and Bells. By Larry Kettelkamp. 48 pp. '60. Morrow	4	2.75
A companion volume to "Singing Strings." Gives directions for making rattles, drums, a xylophone, and a water-glass carillon. Briefly treats history and development of percussion instruments and tells how their sounds are produced. Useful in study of sound as well as in music.		
Exploring the Air Ocean. By Frank H. Forrester. 70 pp. '60. Putnam	4	2.75
The development of instruments used in weather forecasting, mapping the weather and "space-age weather." Illustrations include clarifying maps and diagrams. No index.		
Great Mysteries of the Earth. By Charles H. Hapgood. 72 pp. '60. Putnam	4	2.75
How the earth began and some of its history; the "mystery" of continents, oceans, mountains, ice ages, mammoths, volcanoes and hot climates at the poles. Illustrated with line drawings largely imaginative. No index.		
Numbers Old and New. By Irving and Ruth Adler. 48 pp. '60. Day	4	2.00
Answer questions such as why we count by 10's; how we count by 60's for certain purposes; how numbers can be drawn as triangles, rectangles and other shapes; and how to multiply on your fingers. Appropriate illustrations clarify the text. No index.		
Rays and Radiation. By Robert Scharff. 72 pp. '60. Putnam	4	2.75
The nature of different forms of radiation from those that we can see to those from the atom and outer space. Brief glossary and index.		
Rock Oil to Rockets; the Story of Petroleum in America. By Dirk Gringhuis. 28 pp. '60. Macmillan	4	3.00
A well illustrated story of petroleum in America. There is only one full page drawing with five lines of superimposed text that tell about rockets. No table of contents or index.		
Science on the Shores and Banks. By Elizabeth K. Cooper. 187 pp. '60. Harcourt	4	3.00
Introduction to plant and animal life in or near bodies of water. Includes directions for collecting specimens and performing a few experiments.		
Shells Are Where You Find Them. By Elizabeth Clemons. 128 pp. '60 Knopf	4	2.75

	Grade	Price
How to collect shells and how to keep them. Includes shells found on both the Atlantic and Pacific Coasts. Numerous line drawings.		
Small Pets from Woods and Fields. By Margaret Buck. 72 pp. '60. Abingdon	4	$3.00
Instructions for building terrariums and cages to house small animals including frogs, snakes and insects. Directions for care and feeding are given.		
The Mound Builders. By William E. Scheele. 60 pp. '60. World	4	2.50
Dealing with the prehistoric mound builders of the Ohio River Valley (the Hopewell Indians) the author discusses not only the reconstructed culture by archeologists, but also methods employed in the search and interpretation of methods. Profusely illustrated with maps, drawings and diagrams.		
Time for You. By Duane Bradley. 110 pp. '60. Lippincott	4	2.75
An interesting account of the ways in which man has attempted to tell time from the shadow stick of primitive man to modern calendars and watches. Historical approach. No index.		
All About Undersea Exploration. By Ruth Brindze. 145 pp. '60. Random	5	1.95
How scientists explore the ocean depths. "Helmet and Scuba Diving," "Descent by Bathysphere and Bathyscaphe," "Exploration by Submarines," "Underwater Photography," "The Search for Oil" are some of the chapter titles. Photographic illustrations. Bibliography and index.		
Atomic Energy. By Vera K. Fischer. 28 pp. '59. Maxton	5	1.38
A brief account of some of the characteristics of matter and the steps that led to the development of the atomic bomb.		
Atomic Power for People. By Edward Radlauer and Ruth Shaw Radlauer. 48 pp. '60. Melmont	5	1.88
Explains how physicists, mechanical engineers, metallurgists, electronic engineers and mathematicians cooperate in planning and building a reactor. Illustrated with photographs.		
Exploring Under the Earth. By Roy Gallant. 117 pp. '60. Garden City Books	5	2.95
Information about volcanoes, mountains, the ocean floor and other features of the earth. Maps, charts and diagrams help clarify the text.		
Fun with Scientific Experiments. By Mae and Ira Freeman. 60 pp. '60. Random	5	1.50
57 suggestions for "experiments" with adequate text to explain what to do and what happens. Many black-and-white illustrations. Copious illustrations, largely photographic, include several explanatory diagrams. No index. Table of contents adequate.		
Mountains on the Move. By Marie Halun Bloch. 96 pp. '60. Coward-McCann	5	3.50
A description of the changes that have taken place on the surface of the North American continent and information about the natural forces that have brought about these changes. Photographs, maps, index.		
Paper. By Jerome S. Meyer. 91 pp. '60. World	5	3.00
A history of paper making and an excellent description of modern paper making plants and machinery. Large photographs in black-and-white, sources given. Indexed.		
Science Puzzlers. By Martin Gardner. 128 pp. '60. Viking	5	2.00

	Grade	Price
A book of experiments and stunts for pupils especially interested in science. Concentration on experiments requiring no special equipment. Emphasis on simple but puzzling phenomena that teach something of importance about science, such as the fact that a hard boiled egg will spin readily on a plate while a raw egg will not. Bibliography.		
Understanding Light. By Beulah Tannenbaum and Myra Stillman. 144 pp. '60. Whittlesey	5	$3.00
Information about sunlight, electromagnetic spectrum, the eye and its relation to light, artificial light, solar batteries and similar topics. Illustrated with many line drawings and a few photographs. Excellent index.		
Good Digging. By Dorothy and Joseph Samachson. 224 pp. '60. Rand McNally	6	3.50
Discusses the history and development of archeology as a science and its interdependence with other sciences. Includes numerous important archeological discoveries, the training of an archeologist, preparations for an expedition, and value of the science. Indexed, illustrated with maps and photographs, glossary appended. Better readers.		
Science, Science, Science. By Russel Hamilton. 210 pp. '60. Watts	6	2.95
Previously published selections about science and scientists taken from periodicals and books. Includes men such as Socrates, Archimedes, Galileo and Darwin as well as modern day space scientists. Indexed.		
The Earth for Sam. By W. Maxwell Reed. Rev. ed. Ed. by Paul F. Brandwein. 236 pp. '60. Harcourt	6	4.95
This new edition of an old favorite first published in 1926 has many new photographs and a text thoroughly revised to include the latest scientific findings in the field of geology. An index has been added and the book completely reset.		
The Sea for Sam. Rev. ed. By W. Maxwell Reed and Wilfrid Bronson. Rev. Ed. Ed. by Paul F. Brandwein. 243 pp. '60. Harcourt	6	4.95
First published in 1935, this edition, completely reset, contains much new material, many new photographs for which sources are listed, and an excellent index.		
The Wonderful World of Communication. By Lancelot Thomas Hogben. 69 pp. '59. Garden City Books	6	2.95
Fascinating although conglomerate illustrations add greatly to a difficult text tracing the history and development of communication from cave paintings to television.		

Insects

	Grade	Price
Here Come the Bees. By Alice Goudey. 96 pp. '60. Scribner	2	2.50
A well illustrated account of how bees live and work.		
Grasshoppers and Crickets. By Dorothy Childs Hogner. 62 pp. '60. Crowell	3	2.50
An excellent well-illustrated discussion of the external and internal characteristics of these insects, including descriptions of several different kinds of grasshoppers and crickets among which are some once popular as pets in China. Simple index.		
The How and Why Wonder Book of Insects. By Ronald N. Rood. 48 pp. '60. Grosset	3	1.00
Answers questions about the life cycles of insects and explains the characteristics of several orders. Tells how to collect and preserve insects. Drawings in color and black-and-white.		

	Grade	Price
Dragonflies and Damselflies. By Mary Geisler Phillips. 96 pp. '60. Crowell	5	$2.50
A well-illustrated book which uses the necessary scientific names to help children understand our system of classification. Includes directions for preserving and mounting Odonata and sources of materials and other books of value to beginning collectors. Well-indexed.		
Wonder Workers of the Insect World. By Hiram J. Herbert. 160 pp. '60. Dutton	6	3.00
Descriptions, stories and life cycles of fourteen different insects including wasps, a dragonfly, spiders (which the text explains are not insects), an ant lion, a cicada, a firefly, locusts, a mosquito and butterflies.		
Physiology		
How Things Grow. By Herbert S. Zim. 64 pp. '60. Morrow	4	2.50
Major emphasis is on human growth. Briefly discusses the physical, mental, emotional and social growth of human beings. Many illustrations supplement the text. A few charts will need some explanation for most children.		
The Story of Your Blood. By Edith Lucie Weart. 64 pp. '60. Coward-McCann	4	3.00
A very adequate description of the heart, composition of blood, and circulation of blood in the human body. Includes information about blood types. A few simple experiments add clarity. Well illustrated with drawings in black-and-white. Glossary, no index.		
All About Great Medical Discoveries. By David Dietz. 140 pp. '60. Random	5	1.95
Begins with medicine in ancient days and then tells of the discovery of germs, the development of vaccination, control of yellow fever, the development of anesthetics, discovery and use of X-rays and the fight against polio. Pronouncing index.		
Shots Without Guns; The Story of Vaccination. By Sarah Riedman. 232 pp. '60. Rand McNally	6	3.50
Well-illustrated with 45 photographs and competently indexed in sufficient detail, this account of the achievements of scientists who have developed vaccines, antitoxins, and serums—from Jenner and Pasteur to Salk and Sabin—has reference value for all and reading interest for the mature child interested in medical pioneers.		
The Wonderful Story of You; Your Body, Your Mind, Your Feelings. By Benjamin Charles and Sidonie Gruenberg. 182 pp. '60. Garden City Books	6	2.95
For teacher use with children is this straightforward discussion for older boys and girls of the growth and development of human beings from conception to adulthood. By the author of "The Wonderful Story of How You Were Born" and her husband.		
Plants		
A Tree Is a Plant. By Clyde Robert Bulla. 40 pp. '60. Crowell	1	2.35
A "Let's Read and Find Out" book that describes the life cycle of an apple tree with accurate text and imaginative illustrations that will appeal to young children.		
How a Seed Grows. By Helene J. Jordan. 40 pp. '60. Crowell	1	2.35
A "Let's Read and Find Out" book for young children with easy to read text. Accurate except for the statement "Food for the seed is in the soil." Drawings are not exact representations.		

	Grade	Price
The True Book of Plant Experiments. By Illa Podendorf. 48 pp. '60. Children's Press	1	$2.00
Includes suggestions for germinating seeds in such a way that growth can be observed, studying the rise of water in roots and stems, observing vegetative reproduction and observing spore bearing plants. Continual use of the phrase "baby plants" detracts from an otherwise acceptable presentation.		
What Is a Plant? By Gene Darby. 48 pp. '60. Benefic	1	1.60
An extremely simplified explanation of seed development and plant growth. Oversimplification is well illustrated by the statement "Many plants sleep in the winter." Illustrations in color.		
The Wonderland of Plants. By Terry Shannon. 32 pp. '60. Whitman	3	2.75
A few paragraphs about algae, fungi, mosses and ferns with the remainder of the book devoted to plants which produce seeds. Illustrated in black-and-white and in brilliant color.		
Botany. By. M. K. Hage, Jr., and M. Vere DeVault. 48 pp. '60. Steck	4	1.75
Describes the parts of plants and the functions they perform. In some cases oversimplification results in inaccurate statements. This criticism also applies to the directions for performing simple experiments. No index.		
Grasses. By Irmengarde Eberle. 64 pp. '60. Walck	4	2.75
Describes the various kinds of grasses that grow in different parts of the world and the ways they are used.		
How to Grow House Plants. By Millicent E. Selsam. 96 pp. '60. Morrow	5	2.50
Information about the structure and physiology of plant growth and how to grow plants in homes or schoolrooms. Specific details about some of the most hardy plants that are commonly grown indoors. Useful fact-index and "Where to Buy House Plants and Supplies."		
State Trees. By Olive L. Earle. 36 pp. '60. Morrow	5	2.50
Leaf, flower, fruit and growth characteristics of each of the "State Trees." Also includes some information about economic values. Index in front of volume, arranged by state. Arrangement in book itself, alphabetical by tree name.		
Timber! Farming Our Forests. By Walter Buehr. 96 pp. '60. Morrow	5	2.75
A brief account of lumbering in the United States. Describes early lumbering practices and modern improvements, modern tree farming, uses of wood and the kinds of machines used in the woods and mill. Well indexed.		
High Timber. The Story of American Forestry. By Charles I. Coombs. 223 pp. '60. World	6	4.95
A brief history of lumbering is followed by a detailed account of modern logging, lumber mills, lumber products, the importance of forests to water and wildlife conservation, the recreational value of forests and finally fire danger and pests. Photographic illustrations, for which sources are given. Comprehensive index.		

Rockets, Jets and Space Travel

	Grade	Price
Aircraft and How They Work. By William P. Gottlieb. 56 pp. '60. Garden City Books	3	2.95
Numerous photographs, diagrams and drawings help explain fundamental principles of flight. Experiments described utilize materials available in every home.		

	Grade	Price
Satellites in Outer Space. By Isaac Asimov. 80 pp. '60. Random..	3	$1.95

A very good beginner's book on natural and man-made satellites. Describes what we have learned about the particles in space and some of the problems of space travel. Well illustrated with large clear drawings. Chronology of satellite and space probes. Indexed.

The Story of the Wheel. By Walter Buehr. 47 pp. '60. Putnam.... 3 2.75

Emphasis is on the changes in our lives that have been brought about because of the development and use of wheels. Pictures help develop the contrast between "before and after" the wheel. Chronological approach. No table of contents and no index.

Beyond Mars. By William Nephew and Michael Chester. 72 pp. '60. Putnam.... 4 2.75

The authors, both of whom are missile scientists, describe in simple narrative style the problems that would be encountered in a trip to one of the outer planets or a star.

Project Mercury. By Charles Coombs. 64 pp. '60. Morrow....... 4 2.75

A description of a giant Atlas rocket and the plans that are being made for a man to make a journey through space.

The How and Why Book of Rockets and Missiles. By Clayton Knight. 48 pp. '60. Grosset.... 4 1.00

An excellent introduction to rocket fuels, types of rockets and missiles and the problems of space flight. Drawings in color and black-and-white.

Space Monkey. The True Story of Miss Baker. By Olive Burt. 64 pp. '60. Day.... 4 2.50

How a small monkey was trained for space travel and how she reacted to the trip she took. Probably will interest children because of their interest in animals. Will add little to their usable scientific knowledge.

The Rockets' Red Glare. The Challenge of Outer Space. By Mortimer W. Lawrence. 121 pp. '60. Coward-McCann.... 4 2.75

An excellent account of what we can expect in space in the next few years. Includes information about astronauts and the problems they will encounter in space travel. Profusely illustrated with photographs, charts, and diagrams. Adequate glossary and index.

Count Down. Behind the Scenes at Our Missile Bases. By C. B. Colby. 48 pp. '60. Coward-McCann.... 5 2.00

Includes photographically illustrated information about missile bases, missiles, types of fuels and machinery used in transporting and launching missiles. Usual Colby format.

Discoverer: The Story of a Satellite. By Michael Chester and Saunders B. Kramer. 48 pp. '60. Putnam.... 5 2.50

The story of our nation's satellite program. Excellent large photographs make up a major portion of the book. Describes Project Discoverer, emphasizing launchings of Agena, Midas and Samos satellites. Brief glossary, no index.

First Men in Space. By Erik Bergaust. 47 pp. '60. Putnam...... 5 2.50

An account of Project Mercury with seven pages devoted to biographical data concerning the astronauts, including photo portraits. Large photographs and adequate text to present the basic ideas of space travel. Brief glossary, no index.

Planet Trip. By William Nephew and Michael Chester. 72 pp. '60. Putnam.... 5 2.75

A good description of the planet Mars and an interesting story

	Grade	Price
of an imaginary trip to Mars, emphasizing the possibilities of actual space travel for the boy of today. Scientific possibilities, rather than scientific facts. No index needed.		
Rockets of the Air Force. By Erik Bergaust. 48 pp. '60. Putnam...	5	$2.50
Excellent photographs and information about the rockets developed by the United States Air Force. "The Language of Astronautics," condensed from an Air Force publication is a valuable glossary. No index.		
Rockets of the Army. By Erik Bergaust. 48 pp. '60. Putnam......	5	2.50
Photographs of and data concerning all of the Army's rockets. Includes a glossary of rocket and missile terms, but no index.		
Starbound. The Story of Rocketry. By Eileen and Raymond Schussler. 160 pp. '60. Putnam..................................	5	2.95
The first 103 pages describe events in rocketry that have happened or are expected to happen soon. The rest of the book projects into the possibilities of space travel in the future. Indexed.		
Man's Reach into Space. By Roy A. Gallant. 152 pp. '59. Garden City Books...	6	3.50
Informative yet striking captioned illustrations add clarity to a text concerned especially with the effects upon the human body and mind of the conditions of space flight.		

Transportation

	Grade	Price
Atomic Submarine. By Russell Hoban. Unpaged. '60. Harper....	3	2.57
A clear explanation of the mechanics of an atomic submarine. Can be read by many third graders.		
Balloons—From Paper Bags to Skyhooks. By Peter Buchard. 48 pp. '60. Macmillan..	5	3.75
A profusely illustrated colorful book which describes many types of balloons and some of the flights that have been made.		
The Wright Brothers. By Henry Thomas. 126 pp. '60. Putnam...	5	2.50
A simple, interesting account of the Wright brothers' attempts to build a machine that would fly.		
World Aloft. By Guy Murchie. 289 pp. '60. Houghton, '60.......	6	3.75
An edition of *Song of the Sky* (published 1954) for the teenage reader. About half as long as the original but updated with correction of errors, this discussion of every aspect of the airman's world will interest the gifted and have reference value for the average. Indexed.		

Publishers and Their Addresses

Abingdon: Abingdon Press, 201 Eighth Avenue, Nashville 2, Tennessee.
Benefic: Beckley Cardy Company, 1900 North Narragansett, Chicago 39, Illinois.
Children's Press: Children's Press, Jackson Boulevard and Racine Avenue, Chicago 7, Illinois.
Coward-McCann: Coward-McCann, Inc., 210 Madison Avenue, New York 16, New York.
Crowell: Thomas Y. Crowell Company, 432 Park Avenue South, New York 16, New York.
Day: The John Day Company, 210 Madison Avenue, New York 16, New York.
Doubleday: Doubleday and Company, Inc., 575 Madison Avenue, New York 22, New York.
Dutton: E. P. Dutton and Company, Inc., 300 Park Avenue South, New York 10, New York.
Follett: Follett Publishing Company, 1010 West Washington Boulevard, Chicago 7, Illinois.

Garden City: Garden City Books, 575 Madison Avenue, New York 22, New York.
Grosset: Grosset and Dunlap, Inc., 1107 Broadway, New York 10, New York.
Harcourt: Harcourt, Brace and Company, Inc., 750 Third Avenue, New York 17, New York.
Harper: Harper and Brothers, 49 East 33rd Street, New York 16, New York.
Holt: Henry Holt and Company, Inc., 383 Madison Avenue, New York 17, New York.
Houghton: Houghton Mifflin Company, 2 Park Street, Boston 7, Massachusetts.
Knopf: Alfred A. Knopf, Inc., 501 Madison Avenue, New York 22, New York.
Lane: Lane Publishing Company, Menlo Park, California.
Lippincott: J. B. Lippincott Company, 227-231 South Sixth Street, Philadelphia 5, Pennsylvania.
Maxton: Follet Publishing Company, 1000-1018 West Washington Boulevard, Chicago 7, Illinois.
Macmillan: The Macmillan Company, 111 New Montgomery Street, San Francisco 5, California.
Melmont: Melmont Publishers, Inc., 310 South Racine Avenue, Chicago 7, Illinois.
Morrow: William Morrow and Company, 425 Fourth Avenue, New York 16, New York.
Putnam: G. P. Putnam's Sons, 210 Madison Avenue, New York 16, New York.
Rand: Rand McNally and Company, P.O. Box 7600, Chicago 80, Illinois.
Random: Random House, Inc., 33 West 60th Street, New York 23, New York.
Scribner: Charles Scribner's Sons, 597 Fifth Avenue, New York 17, New York.
Steck: Steck Company, Ninth and Lavaca Streets, Austin 1, Texas.
Sterling: Sterling Publishing Company, Inc., 419 Fourth Avenue, New York 16, New York.
Vanguard: Vanguard Press, Inc., 424 Madison Avenue, New York 17, New York.
Viking: The Viking Press, 625 Madison Avenue, New York 22, New York.
Walck: Henry Z. Walck, Inc., 101 Fifth Avenue, New York 3, New York.
Watts: Franklin Watts, Inc., 575 Lexington Avenue, New York 22, New York.
Whitman: Albert Whitman and Company, 560 West Lake Street, Chicago 6, Illinois.
Whittlesey: McGraw-Hill Company, 330 West Forty-second Street, New York 36, New York.
World: World Publishing Company, 2231 West 110th Street, Cleveland 2, Ohio.

MARINE LIFE UNDER ARCTIC ICE STUDIED

The first plankton samples collected by a submarine under the polar ice are now being studied by scientists in the United States.

The scientists are trying to determine the area where the marine life of the North Atlantic Ocean begins to mingle with that of the North Pacific.

Samples were collected last summer by the nuclear submarine, *Seadragon*, during its voyage under the frozen ice of the North Pole.

The samples were collected by an automatic sampling device built for the trip. The device, which is attached to the submarine's conning tower, uses tiny nets for scooping samples of plankton each hour from the Arctic water. After each 24-hour run the sampler automatically shuts itself off. When the submarine surfaces, the samples are removed and frozen.

In the past, plankton samples from underneath the ice were obtained by lowering nets through holes drilled through the ice.

An Easily Understood Mathematical Derivation of $S=\frac{1}{2}at^2$ and $S=v_it\pm\frac{1}{2}at^2$

Arthur H. Pedley

Canajoharie Central School, Canajoharie, New York

Most students of high school physics have finished a course in plane geometry which includes, in many states, concepts of analytic geometry. With this background it is possible to logically derive the basic formulas used in the study of uniformly accelerated motion in high school physics. The only additional information that is needed is known by all school youth—that the distance traveled by a body with uniform velocity is equal to the velocity multiplied by the time the velocity was maintained. Simply, $D=VT$. (A)

As is customary in physics, the letter S will be used to represent distance in the following discussions.

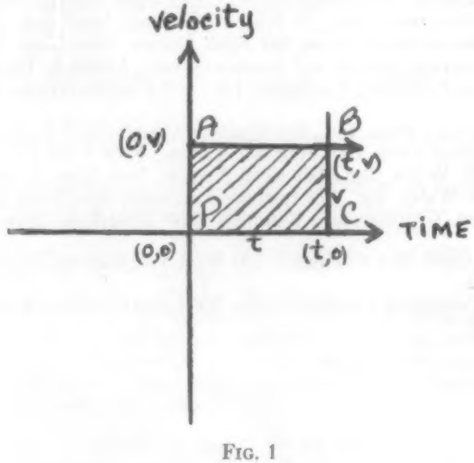


FIG. 1

Consider a rectangular coordinate system whose horizontal axis represents time and whose vertical axis represents velocity. (See figure 1.) Line AB represents a body traveling with an average velocity of V. Line CB is a vertical line drawn through the point $(t, 0)$ which represents a time during which the body has been maintaining this average velocity, V. Now the area of the rectangle $PCBA$ is equal to $CB \times PC$ or $V \cdot t$ and since the distance this body travels during the period of time, t, at an average velocity, V, equals Vt (see A), it is obvious that *the area of the rectangle truly represents the distance traveled by the body*. This is a basic concept. (B)

Now consider a body starting from rest, possessing a zero velocity, and being acted upon by a constant, unchanging, uniform acceleration which acts to change the velocity of the body linearly along the line PB. (See figure 2.) At some time later, say t_f, a vertical line CB will intersect PB at the point (t_f, v_f), where v_f is the velocity attained by the body after the time t_f has elapsed.

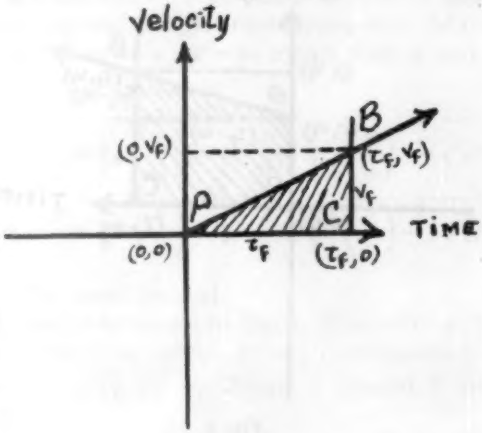


FIG. 2

The definition of acceleration tells us that acceleration is *the time rate of change of the velocity of a body* and this is merely *the slope* of the line PB! The slope of PB = rise/run or the slope of $PB = v_f/t_f$. Hence the acceleration, $a, = v_f/t_f$ or, multiplying by t_f, $at_f = v_f$. (C)

As shown previously (see B), the area of triangle PCB is equivalent to the distance, S, covered by the body in the time t_f. This area equals $\frac{1}{2}\ CB \times PC$ or $\frac{1}{2}\ v_f\ t_f$ and hence $S = \frac{1}{2}v_f t_f$. Now, since $at_f = v_f$ (see C) by substituting, $S = \frac{1}{2}at_f t_f$ or $S = \frac{1}{2}at_f^2$ or simply $S = \frac{1}{2}at^2$!

Finally, consider a body given an initial velocity, v_i, and being acted upon by a uniform acceleration over a period of time starting at zero time and ending at a time, t_f. Again the velocity of the body changes linearly and will follow the path AB. (See figure 3.)

As demonstrated previously, the area of the trapezoid $PACB$ represents the distance S covered by this body during the period of time t_f. The area of the trapezoid $= \frac{1}{2}\ PC\ (PA + CB) = \frac{1}{2}t_f\ (v_i + v_f)$. Therefore $S = \frac{1}{2}t_f(v_i + v_f)$.

Now the acceleration of the body equals the slope of the line AB and this slope equals $(v_f - v_i)/(t_f - 0)$ or $a = (v_f - v_i)/t_f$. Upon solving this for v_f it is found that $v_f = at_f + v_i$. Substituting this in $S = \frac{1}{2}t_f(v_i + v_f)$ we obtain $S = \frac{1}{2}t_f(2v_i + at_f)$ and upon removing parentheses, $S = v_i t_f + \frac{1}{2}at_f^2$ or simply $S = v_i t + \frac{1}{2}at^2$.

At this point it is necessary to consider that a body that is moving under a uniform acceleration which is decreasing its velocity has its acceleration taken negatively to indicate decceleration. Hence under these conditions we would obtain the equation $S=v_i t-\frac{1}{2}at^2$. This accounts for the commonly seen equation $S=v_i t\pm\frac{1}{2}at^2$.

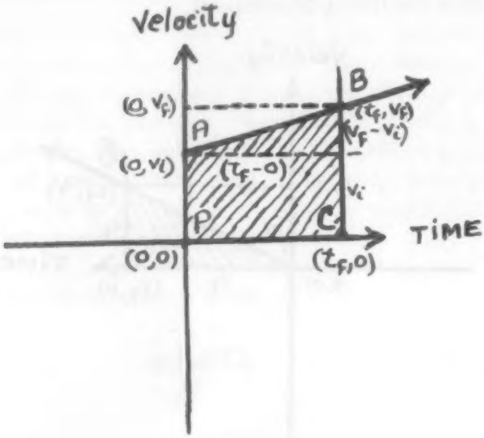


FIG. 3

ABNORMAL CHROMOSOME FOUND IN CEREBRAL PALSIED CHILDREN

Abnormal chromosomes have been found in a brother and sister with cerebral palsy.

This indicates that cerebral palsy, in some cases at least, like another defect which affects the brain and mind, Mongolism, is hereditary. Both may be due to a mistake in chromosome duplication that takes place in the germ cells of the parents before the child is conceived.

The two children studied had not only an unusual spastic-aspastic type of cerebral palsy, but congenital cataract as well.

Studies of the chromosome arrangement showed, that in each child, one of the chromosomes was misshapen and seemed to have no corresponding duplicate. The chromosome number was the usual 46. The scientists finally found that the abnormal chromosome was the X sex chromosome. It did have a mate, but the mate was normal.

Both parents were normal. But the fact that the X sex chromosome was abnormal in both the boy and the girl led the investigators to propose this theory.

Before the mother herself was born, that part of the body which would become the cells she would pass on to her children underwent a change. The chromosomes in the vital egg cells changes and the pattern was set for the misshapen X chromosome, later inherited by her son and daughter.

The daughter, with an abnormal X from the mother and a normal X from the father, is somewhat less afflicted than the son, who has the abnormal X from the mother and a normal Y chromosome from the father. The normal X is believed to cut down on the damaging effects produced by the abnormal one, and the boy lacks the modifying X. (Females have two X chromosomes, males have an X and a Y chromosome.)

Geometric Solution of a Quadratic Equation

D. Mazkewitsch
University of Cincinnati, Ohio

Presented is a method for a graphical solution of quadratic equations with both real and complex roots, using only the compass.

Consider the equation a) $x^2-px+q=0$ with p and q real. The roots are

$$x_1=\frac{p}{2}+\sqrt{\left(\frac{p}{2}\right)^2-q}=\frac{p}{2}+\sqrt{\left(\frac{p}{2}\right)^2-(\sqrt{q})^2}$$

$$x_2=\frac{p}{2}-\sqrt{\left(\frac{p}{2}\right)^2-q}=\frac{p}{2}-\sqrt{\left(\frac{p}{2}\right)^2-(\sqrt{q})^2}$$

1) $(p/2)^2>q$. The roots are real.

$\sqrt{q}$ is constructed as shown in Fig. 1. With $AB=p/2$ as diameter draw a half circle. With radius $AC=\sqrt{q}$ determine C on the half circle. Then $CB=\sqrt{(p/2)^2-q}$. Rotate C around B into E and D. Then (Fig. 2)

$$AD=\frac{p}{2}+\sqrt{\left(\frac{p}{2}\right)^2-q}=x_1$$

$$AE=\frac{p}{2}-\sqrt{\left(\frac{p}{2}\right)^2-q}=x_2$$

2) $(p/2)^2<q$. The roots are complex.

Write the expression for the roots as

$$x=\frac{p}{2}\pm i\sqrt{(\sqrt{q})^2-\left(\frac{p}{2}\right)^2}$$

Draw the half circle with $AB=\sqrt{q}$ as diameter. $AB=\sqrt{q}$, $AC=p/2$. CB gives the numerical value of the imaginary part of the roots (Fig. 6).

For the equation

$$\text{b) } x^2+px+q=0$$

lay off AB in the negative direction (Fig. 3). For the equation

$$\text{c) } x^2-px-q=0,$$

we have

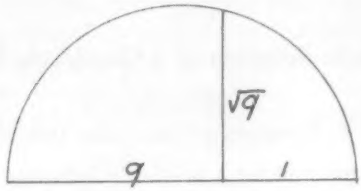


FIG. 1

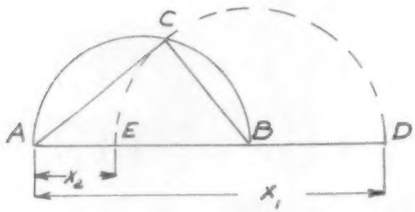


FIG. 2

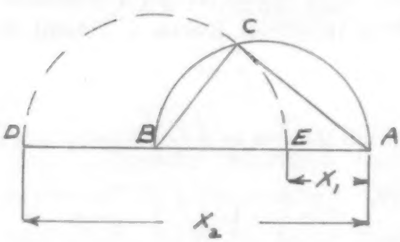


FIG. 3

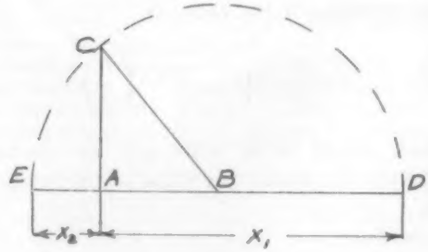


FIG. 4

$$x_1=\frac{p}{2}+\sqrt{\left(\frac{p}{2}\right)^2+(\sqrt{q})^2}, \qquad x_2=\frac{p}{2}-\sqrt{\left(\frac{p}{2}\right)^2+(\sqrt{q})^2}$$

Constructing $\sqrt{q}$ as before, we have in Fig. 4

$$BC=\sqrt{\left(\frac{p}{2}\right)^2+q}; \qquad AD=x_1; \qquad AE=x_2$$

We see that in equations of type c) of the two roots the smaller one is negative. For

$$\text{d)}\quad x^2+px-q=0,$$

Fig. 5, which is self explanatory gives the roots.

We see that in equations of type d) of the two roots the greater one is negative.

To apply what has been presented above to the solution of any quadratic equation make the following graph (Fig. 7).

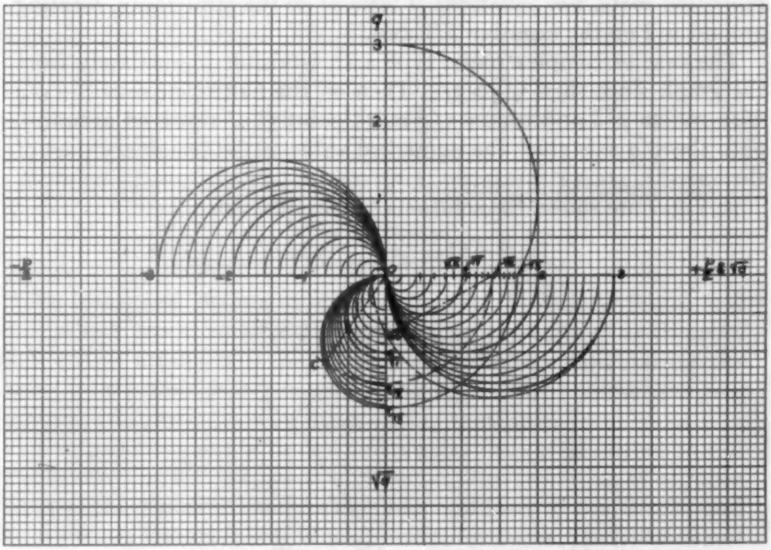


Fig. 7

In the figure, one unit is taken $=1''$.

Below 0, on the vertical $\sqrt{q}$ lay off 1 (in the figure it is marked $\sqrt{1}$). On the same vertical, $0q$ above 0, lay off .1, .2, $\cdots$, 1, $\cdots$, 3. Over $1-.1$, $1-.2$, $\cdots$, $1-3$ as diameters, draw half circles which intersect the horizontal axis $\sqrt{q}$ at $\sqrt{.1}$, $\sqrt{.2}$, $\cdots$, $\sqrt{3}$. (In the figure only the construction of $\sqrt{3}$ is shown.) Rotate these points around 0 as center onto the vertical axis $\sqrt{q}$. (In the figure only the points $\sqrt{1}$, $\sqrt{2}$, $\sqrt{3}$, $\sqrt{.6}$ are marked.) Over $0-\sqrt{.1}$, $0-\sqrt{.2}$, $\cdots$, $0-\sqrt{3}$ as diameters draw half circles. (In the figure they are drawn to the left of the vertical axis.)

On the horizontal axis each division represents .1. Over $0-.1$, $0-.2, \cdots, 0-3$, $0-(-1)$, $0-(-2), \cdots, 0-(-3)$ draw half circles. (In the figure the half circles over $0-.2$, $0-.4, \cdots, 0-3$ are drawn below the horizontal axis; the half circles over $0-(-.2)$, $0-(-.4), \cdots, 0-(-3)$ are drawn above the horizontal axis.)

For equations of type a) intersect with radius $0-\sqrt{q}$ and center 0 the circle with radius $p/4$ and center $p/4$ on the positive $p/2$ axis. Rotate this point of intersection around $p/2$ on the positive $p/2$ axis onto the $p/2$ axis obtaining on it the requested roots. For equations of type b) do the same thing taking the center $p/4$ on the negative $p/2$ axis.

For equations of type c) rotate point $\sqrt{q}$ on the $\sqrt{q}$ axis around $p/2$ on the positive $p/2$ axis onto the $p/2$ axis obtaining on it the requested roots. For equations of type d) do the same thing, rotating around $p/2$ on the negative $p/2$ axis.

The case of complex roots, type a.2), is visible immediately from the graph since then $\sqrt{q}>p/2$. Then on the half circle over $0-\sqrt{q}$ with radius $p/2$ and center $\sqrt{q}$ mark point C. C revolved around 0 onto the $\sqrt{q}$ axis gives the numerical value of the imaginary part of the roots.

In Fig. 7 are shown the solutions of the equations:

$$1)\ x^2-2.8x-.6=0 \text{ (type } c)),$$

and

$$2)\ x^2-2x+3=0 \text{ (type a.2))}$$

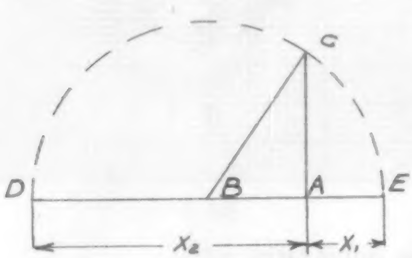


FIG. 5

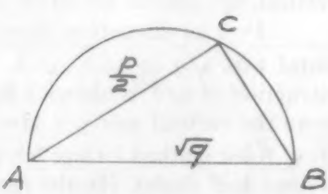


FIG. 6

For 1) the point $\sqrt{.6}$ on the $\sqrt{q}$ axis has been rotated around point 1.4 on the $+p/2$ axis onto the $p/2$ axis, giving $-.2$ and 3. For 2) on the half circle over $0-\sqrt{3}$ point C has been marked with radius 1 and center $\sqrt{3}$; then the point C has been rotated around 0 onto the $\sqrt{q}$ axis, giving 1.41.

This particular graph may be used for equations with coefficients $0 \leq |p| \leq 2.6$ and $0 \leq |q| \leq 3$.

I wish to thank Professor Jacob H. Sarver, head of the Department of Engineering Graphics for having drawn Fig. 7.

A Brief Historical Overview of Arithmetic Methodology

Paul C. Burns
University of Kansas, Lawrence, Kansas

The history of airthmetic methodology in the United States is a topic which has received little attention by students of arithmetic. This article attempts to picture arithmetic instruction during the period from about 1900 through 1925 as reflected in a number of professional arithmetic books written during that time.

Early professional books devoted a good deal of attention to the development of the subject of arithmetic. The unfolding of number concept; the contributions of early man and later of the Greeks and the Romans; the evolution of arithmetic algorisms; the influence of persons as Pestalozzi, Tillich, Kranckes, Grube and others; treatises on yet earlier arithmetic in the public schools of the United States—these are topics frequently touched upon in such books (18:1–19).

Issues relative to a satisfactory arithmetic course of study were prominent in a number of professional books. A comparison of American and European courses, the grade distribution of topics, and time allotments were widely discussed (18:20–38). The consensus was that the placement of topics in the United States schools was generally about one year behind the comparable grade level in the foreign schools. There was some early research to indicate the grade distribution of topics and time allotment for the subject of arithmetic at that time, yet no evidence as to what should be the practice:

The forty-five combinations are completed by a majority of schools in the second grade. About ten per cent complete these in the third grade and only four per cent in the first grade. The multiplication tables are generally completed in the third grade, though there is greater variation in this particular than in the completion of the forty-five combinations. The fourth grade is the grade of long division. About twenty per cent of the schools teach the topic in the third grade and three per cent in the fifth. Formal fractions are taught in the fifth grade by the majority of schools. Twenty-eight schools teach addition and subtraction of fractions and multiplication and division of fractions in different grades. In nineteen of these cases the first two processes are taught in the fourth grade and the latter in the fifth. Decimal fractions likewise are taught in grades five, six, and seven, yet the fifth grade is predominantly the grade in which decimal fractions are taught. Although percentage appears in the sixth, seventh, and eighth grades, and in some cases as low as the fifth, yet the sixth grade is the most frequent grade in which percentage is taught (10:37).

. . . About 13% of the total school time is devoted to arithmetic. This does not tell us whether this is too much or too little. But if the cities in the lower quartile get satisfactory results with only 9% of their total time given to arithmetic, then it is reasonable to suppose that all cities might reduce the time at least as far as the median (10:64).

Other problems with which the writers of the first quarter of the twentieth century were wrestling may also sound familiar: What provisions should be made for individual differences? (The pros and cons of minimum, general, and maximum goals were frequently presented (11:18–25). Is the spiral or the topical approach more effective? (A combination seemed most acceptable, but professional books generally followed the topical approach rather than year-by-year approach in their presentation.) How much oral work is justified as compared with written work? (A frequent statement was that one-third of the recitation time should be devoted to oral work (17:21). When should arithmetic texts be introduced to pupils? (Many writers felt that the third grade was the best grade for introducing the pupil's textbook (25:151). How can arithmetic texts be best selected and used?

Teachers were advised that "adequate scientific standards for judging textbooks have not been determined" (10:134). As to the use of a textbook, teachers were counseled that they should not make the mistake of feeling that everything in it should be undertaken by the class. "One of the distinguishing features of the work in best European schools is the freedom with which the teacher omits matter from textbook and supplies problems of local significance" (25:36–37).

Relative to two or three other questions, further consensus would appear to indicate that writers favored a definite program of arithmetic in the first grade as opposed to an incidental pattern (27:34); that many topics should be eliminated from the courses of study and textbooks: the greatest common divisor; involved processes with fractions (and why not if the example cited in one source (24:6)

was typical: "Divide 19/24 of 28/33 of 11/14 of 71/9 by 23/35 of 5/8 of 16/23 of 8/35 of 24 5/12!"); least common multiple; obsolete tables; problems of longitude and time (example: "If the distance between two places is 46° 18′ 20″, what is the difference in time?"); measurement of lumber, roofing, flooring, plastering, painting, papering; square and cube root; and many business forms (16;26:1–22).

Issues usually left unresolved included such questions as: Should addition and subtraction facts be presented together or separately? What is the best method of teaching subtraction? Should the zero facts be taught? Should long division be taught before short division? What place has the metric system? By what sequence should the multiplication facts be attacked, regular or mixed (23:115–116)? These were considered as debatable issues and, generally speaking, no conclusive recommendations were made.

An effort seemed to be made in the early professional books to be quite explicit in other areas of the instructional program. Fox example, the unit skills, required in the fundamental operation of various processes, such as common fractions, were broken down into rather minute parts. Depending upon the author's pattern, the result was a certain number of types of examples. For example, if common fractions were broken into three patterns—in terms of denominator, addend, and answer—the result was 46 addition types; 65 subtraction types; 70 multiplication types; and 80 division types or a total of 261 types (22:21). Furthermore, extreme care in the gradation of presentation was generally advised. The following might represent a typical proposal of gradation in the treatment of addition of common fractions:

1. Denominators alike
2. Largest denominator the lowest common denominator
3. Same as (1) and (2) except there are three or more addends arranged in column form
4. Column addition, the lowest common denominator larger than any given denominator
5. Mixed numbers, no carrying from fractions to units
6. Mixed numbers, with carrying (21:188–189).

Care was advised in the modes of expression and algorisms that should be presented to children (16:370–372). A list of preferred and unpreferred expressions often included such as the following:

Recommended	*Not Recommended*
Nineteen hundred twenty	Nineteen hundred and twenty
6 2/3=6 8/12	6 2/3=8/12
8 is 2 times as great as 4	8 is 2 times greater than 4
2×3 sq. ft.=6 sq. ft.	2 ft.×3 ft.=6 sq. ft.
1×3 is 3	1×3 are 3
12 divided by 4	4 goes into 12

$8
6×
———
2/40

$8
×6
———
2/40

1 1/2	2
2 3/4	3
4 1/4	5/4

1	1/2=2/4
+2	3/4=3/4
3	+5/4=4 1/4

Generally speaking, the inductive type of lesson was recommended over the deductive lesson (16:27–38; 26:191–205). No little space was devoted to presentation of samples of inductive teaching. While some of the lessons seem formal and lacking in color (8:40–43), others appear to be rich in teaching potential (15:148–179; 19:49–135). At least one or two writers recommended the discovery approach as a general overall procedure.

> This method (of discovery) has many advantages. . . . In the first place it secures thinking on the part of the pupils because it presents the proper situation to cause thinking—that is, a problem situation. None of the other methods do this as they all start by giving the information. In this method, the pupils are confronted with a problem. In the illustration used before, the problem is to discover an easy way to multiply by ten. In order to solve this problem, the pupils must review what they already know about multiplying by ten, compare, draw their conclusion and verify. This method has the further advantage that it encourages the pupils to use what they already know to meet new situations; it trains him to acquire knowledge for themselves; to verify their first conclusions; and not to depend entirely on their teacher and textbook. Finally it is more interesting, simply because of the natural pleasure of discovery and of doing things (19:52–53).

An interesting issue was the question of children's analyses of their work (27:60–68). Some writers felt that if pupils could rationalize their work it was simply "memorized rigmarole." Others defended it on the ground that it helped make clear to the teacher what the pupil understood. The defenders of analyses asked not for blind recitation of formal statements of every example and problem but felt that to neglect it entirely would be quite as serious an error as to go to the other extreme (25:67–71). They felt it was reasonable to achieve understanding from a pupil to the point where he could take the example 1/2 of 3/4 and analyze the work as follows:

"1. By drawing horizontal lines the rectangle is divided into four parts, of which 3 parts are considered.
"2. By means of the vertical line one-half of 3 parts or 1/2 of 3/4 is determined. This gives the 3 smaller or shaded parts.
"3. By continuing the vertical line with dotted line the size of the part is

determined by showing that 8 of the parts are required to make a whole. Hence each part is an eighth . This gives the answer: 3/8" (16:92).

This type of analysis was considered "overelaboration" by those who equated habituation and arithmetic instruction—if these two quotations are typical:

It makes little if any difference whether or not he knows why we carry. The important thing is that he has proper habits of carrying. These acts are taught as memory or habit, inasmuch as they are best performed by the method forever after (26:5).

The child constantly performs operations which he does not understand; he delights to perform them, and grows strong mentally and physically by performing them. In language, he masters a vocabulary of hundreds of words, holds them in memory and recalls them without an effort; but why a spade is called a spade has never occurred to him. Walking, whistling, swimming, are mastered long before the laws of equilibrium, of sound, and of hydrostatics are understood. He learns that b-o-y spells boy; he memorizes the fact; he uses this knowledge as a tool to express thought. Let him also learn that nine times six are fifty-four; let him memorize the fact; let him use this knowledge as a tool in computation. And unless some pedagog should ask him why eight sevens are fifty-six, he will probably never have occasion to inquire (5:34).

Whenever drill was recommended by the professional books, individual drill procedures generally were rated more efficient than class drill procedures. The value of speed was widely stressed (19: 161–174). Checks, proofs, and short cuts were generally approved, particularly those dealing with casting out nine. So, too, were the following: approximation; cancellation; different methods of solution; multiplication and division by powers of ten; and multiplication of aliquot parts (1:185–193; 16:345–364). Objective instruction was generally encouraged, particularly diagrams in the area of fractions. Some writers warned that indiscriminate use of objects was a danger to be aware of and that objective instruction should taper off at more advanced grade levels (27:42–59). Some of the recreational arithmetic called for attention to mathematical curiosities and the like (19:180). Russian multiplication, requiring the ability to add and to multiply and divide by 2, is one example. Pupils were taught that to multiply 85×94, they placed the numerals as below, and halved and doubled them as shown. The numerals in the odd columns (checked) are added for the product.

```
85×   94 √
42—  188
21—  376 √
10—  752
 5—1504 √
 2—3008
 1—6016 √
   ————
   7990
```

Races, games, and puzzles were sometimes encouraged. "Crossing the river" was a popular game (16:377). A number question for Friday's games might have been: "A hare starts 50 leaps before a greyhound, and takes 4 leaps to the hound's 3; but 2 of the hound's leaps are equal to 3 of the hares. How many leaps must the hound make to overtake the hare?" (19:190).

The aims of instruction appeared to be evolutionary rather than static. During this particular period, arithmetic seemed to have come from a scientific, formal discipline. It appeared to have advanced toward an extreme business utility, but was striving to arrive at a broader interpretation of social utility (27:9–20). At least two new influences were bearing upon arithmetic instruction, the project method (12:69–117) and standardized tests. Regarding the project method one author wrote:

> We shall not expect too much of the project method. Long years of scientific investigation will be necessary. In all reforms a sensible compromise is best, retaining the good of the old and adapting the most usable of the new (16:397).

The new standardized tests, such as Rice's, Stone's, Courtis', and Woody's, were being examined for their uses and samples of their content were sometimes included in the books for teacher acquaintance and study (16:9–20; 18:299–318; 26:221–257).

In conclusion, it might be pertinent to point up the fairly universal pleas for teacher competence of the materials which he is to teach if he would rise above the level of barren formalism (6:1–25). It was often stated that the teacher's knowledge of the subject must be greater than the academic knowledge which he obtained as a pupil. An old Scotch adage has it, "He who teaches all he knows, teaches more than he knows." As the source of a water supply for a fountain must be higher than the fountain's spray, so the sources of a teacher's information on a subject need be greater than his output. Writers urged teachers to know something of the historical development of the subject area and an understanding of the logical development of the subject insofar as this might lead to an appreciation, recognition, and understanding of more recent methodology (3; 4; 7; 9; 13; 14; 20). They further felt that this might give teachers a new zeal for the subject; an assurance in the value of what he presents to his pupils (21:Preface).

If this article has indicated somewhat that the thinking done a few years ago on some of the issues of arithmetic instruction is worthy of consideration as a background for today's problems, it will have served its purpose.

Bibliography

1. Brown, Joseph, *How to Teach Arithmetic*, Chicago: Row, Peterson and Co., 1914.

2. Clark, John R.; Otis, Arthur; and Hatton, Caroline, *First Steps in Teaching Numbers:* Yonkers-on-Hudson: World Book Co., 1929.
3. Drummond, Margaret, *The Psychology and Teaching of Number*, Yonker-on-Hudson: World Book Co., 1922.
4. Dunton, Larkin, *Methods of Teaching Arithmetic in Primary Schools*, N. Y.: Silver, 1891.
5. Gillan, S. Y., *Arithmetic in Common School*, Milwaukee: *Gillian*, 1898.
6. Halsted, G. B., *On the Foundation and Technic of Arithmetic*, Chicago: Open Court Publ., Co., 1912.
7. Hamm, Franklin, *Outline and Suggestive Methods and Devices in Teaching Elementary Arithmetic*, Philadelphia: Lippincott Co., 1916.
8. Harwood, S. E., *Notes on Method in Arithmetic*, Terre Haute: The Inland Publ. Co., 1897.
9. Howell, Henry Budd, *A Foundational Study in Pedagogy of Arithmetic*, N. Y.: Macmillan Co., 1914.
10. Jessup, Walter A., *The Supervision of Arithmetic*, N. Y.: Macmillan Co., 1917.
11. Klapper, Paul, *The Teaching of Arithmetic*, N. Y.: D. Appleton Century and Co., 1916.
12. Lennes, Nels, *Teaching of Arithmetic*, N. Y.: Macmillan, 1923.
13. McLaughlin, K. L., *Number Projects for Beginners*, Philadelphia: J. B. Lippincott Co., 1923.
14. McLellan, James A. and Dewey, John, *The Psychology of Number and Its Application to Methods of Teaching Arithmetic*, N. Y.: D. Appleton Century and Co., 1895.
15. McMurry, Charles A., *Special Method in Arithmetic*, N. Y.: Macmillan Co., 1916.
16. McNair, G. H., *Methods of Teaching Modern Day Arithmetic*, Boston, Badger, 1923.
17. New Jersey Dept. of Public Instruction, *Teaching of Elementary Arithmetic*, 1912.
18. Newcomb, Ralph S., *Modern Methods of Teaching Arithmetic*, N. Y.: Houghton Mifflin Co., 1926.
19. Overman, James R., *Principles and Methods of Teaching Arithmetic*, Chicago: Lyons and Carnahan, 1920.
20. Ritter, Carlton M., *Pedagogics Applied to Arithmetic*, Stockton, California: Atwood, 1891.
21. Roantree, William, Taylor, Mary S., *An Arithmetic for Teachers*, N. Y.: Henry Holt and Co., 1925.
22. Ruch, Guy Knight, F. B., Olander, E. A., Russell, and G. E., *Analysis of Drill in Fractions*, University of Iowa Studies in Education, Vol. 10, No. 2, 1936.
23. Schorling, Raleigh, Overman, J. R., Shriner, Walter, *Contemporary Guide in Teaching of Arithmetic*, Ann Arbor, Michigan: Edwards Bros. Inc.
24. Smith, David E., *The Progress of Arithmetic in Last Quarter of a Century*, N. Y.: Ginn and Co., 1923.
25. Smith, David Eugene, *The Teaching of Arithmetic*, Boston: Ginn and Co., 1913.
26. Stone, John C., *The Teaching of Arithmetic*, Chicago: Sanborn and Co., 1918.
27. Suzzalo, Henry, *Teaching of Primary Arithmetic*, Boston: Houghton-Mifflin, 1911.
28. Thorndike, Edward Lee, *The New Methods in Arithmetic*, Chicago: Rand McNally, 1921.

Power Supplies for Small Meteorological Instruments

Ronald L. Ives
2075 Harvard St., Palo Alto, Calif.

Instruments at many of the smaller meteorological installations, particularly those established for instructional or research purposes, commonly function either poorly or expensively because of improperly chosen power supplies. A major cause of this trouble is lack of information, both in the instruction sheets supplied by the instrument manufacturer, and in the handbooks on meteorological and other instrumentation that are currently available. A secondary cause, perhaps, is the virtual disappearance of the intensely practical "general science" courses which graced high-school curricula some thirty years ago.

Complete instructions for designing and procuring power supplies suitable for all meteorological instruments now in use would fill several large-sized books, and would constitute a major part of a good course in electrical engineering. Summary solutions to the most common power supply problems, however, are relatively simple, and will be outlined here, with references to technical source material containing answers to the more involved power supply problems.

Principal power-consuming components of small meteorological instruments are lamps, solenoid-operated pens, meters, or combinations thereof. Some of these operate on direct current, and are usually powered either by batteries or by transformer–rectifier combinations fed from the light line. Other instruments are powered by alternating current, and are powered either directly from the light line, or indirectly through a step-down transformer. Most indicator lamps work equally well on direct and alternating current. Practically all other electrical devices are designed to work only on one kind of current, and are either inoperative on the other, or are damaged by the other. This is particularly true when A.C. devices are connected to a D.C. source.

Although the current type is usually marked on the face of a meter, the terminals also give a clue to the current type for which they are designed. If the meter is for use on A.C , both terminals will usually be the same, while if it is designed for direct current use, one terminal will usually be marked with a + sign, indicating that this terminal must be connected to the positive side of the circuit.

Relays and solenoid pens for use on direct current usually have solid pole pieces, either round or rectangular in cross-section. In contrast, solenoid coils for operation on A.C. usually have laminated cores, and are fitted with a shading ring, which is a *D*-shaped piece of

copper, one arm of which is passed through a slot in the pole piece.

Before we can decide upon the power supply needed for an instrument, we must know not only the requisite current type (A.C. or D.C.), but also the operating voltage, the operating current, and the range of the duty cycle.

Lamp voltages and currents can be determined by reference to the number on the base, which gives either the voltage or the lamp type. A standard lamp catalog will then tell the lamp current, and usually also give an indication of the lamp service life.

Meter characteristics are usually marked on the scale in common units, like "1 ma. full scale" or "Volts D.C., 0-10", and the internal resistance is sometimes also indicated, as "1,000 ohms per volt." A considerable number of meters now available on the surplus market are calibrated in seemingly-irrational units, such as "Milliboogles per Dekablip," and their characteristics can only be determined by inspection followed by electrical tests.

Operating voltages of such items as relays and solenoid pens, if unknown, are best determined by experiment. If a relay just operates at 4.7 volts, its probable rating is 6 volts, and it will probably operate dependably at any voltage from 5 to 7 or more.

Current drain of the device under consideration is best determined by connecting an ammeter or milliammeter in series and noting the deflection, although, if the operating voltage is known, the drain can be found by measuring the resistance (or reactance, if the device operates on A.C.) and computing the current by Ohm's Law.

Most small direct current devices are operated from batteries, which come in a wide variety of sizes, current capacities, and priçes. If the battery chosen is too small for the load, frequent replacements will be necessary, and operating costs will be inordinately high. If the battery chosen is too large, so that it will run the equipment (theoretically) for five or six years, it will depreciate due to age faster than it "runs down" due to use, and operating costs again will be too high. Optimum size of dry battery for most meteorological uses is one that will last from three to six months under the extant load conditions. Where a device is operated for only about one or two weeks in the year, for classroom or other instruction, the most economical battery is one that will just last out the use period.

Dry batteries do not, in general, stand long storage, especially if partly discharged; they are permanently damaged by cold and extreme heat; and they depreciate to questionable value in about two years. For this reason, many of the bargain "war surplus" dry cells now on the market are actually not bargains, and may be useful only as rather expensive door stops.

Choice of the proper dry cell for use in a given situation is best

determined by reference to a good battery manual.[1] For most applications, the load circuit is connected directly across the battery terminals, as in Fig. 1, A. Where the load varies greatly, as when a re-

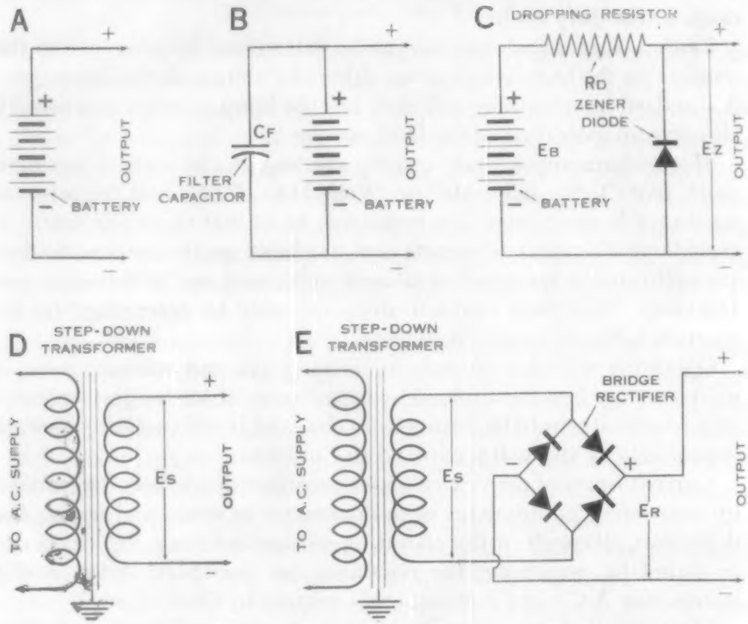


FIG. 1. Simple power supply circuits.

corder pen draws one ampere for 0.5 second every 30 seconds or so, operation is improved by use of a filter capacitor connected directly across the battery, as in Fig. 1, B. This capacitor, which should be several thousand microfarads at 6 volts, acts as an electrical reservoir, reducing the "surge load" on the battery, and somewhat extending its useful life.

For applications requiring constant voltages at low currents, such as in potentiometer-type wind direction indicators, and for the charging circuits of capacitor-discharge wind speed indicators and recorders, mercury batteries, which have a constant output voltage throughout much of their life, are suitable, although somewhat costly, as compared to standard dry cells.

At somewhat higher currents, battery voltage may be regulated by use of a Zener diode, as in Fig. 1, C. The Zener diode is a nonlinear resistor, of such characteristics that, through a wide range of

[1] *Burgess Engineering Manual*, Burgess Battery Co. Freeport, Ill. Current Edition, $1.00 per copy postpaid.

applied voltages, the drop across it is substantially constant. As a result, through a wide (but not infinite) range of battery voltages and load currents, the output of the circuit of Fig. 1, C, will be constant at the Zener voltage, Ez. Technical data for determining Zener diode characteristics for use in specific circuits are given in manufacturers' handbooks.[2] Because a Zener diode regulator circuit imposes a constant load on the battery, whether the load is energized or not, regulation should be applied only to those components which need voltage regulation, and switching, where possible, should be done on the battery side of the regulator circuit.

The foregoing circuits and discussion deal with standard dry cells, which are customarily used once and thrown away. Many of them can be recharged from two to fifteen times, but recharging of standard dry cells is usually uneconomical, and the results may be disappointing.

The same circuits can be applied effectively to the relatively new nickel-cadmium rechargeable dry cells, which have an indefinite, but relatively long life, a high first cost, and a low cost per hour of operation.

Standard lead-acid storage batteries can be used in place of dry cells in all of these circuits, and their operation is economical where current drains average more than half an ampere. Charging and "floating" techniques will be briefly discussed later.

When the meteorological instruments can be operated with Alternating Current, and where an A.C. source, such as the light line, is available, A.C. operation is not only satisfactory, but economically desirable. Whereas dry-cell operation costs in terms of dollars per watt-hour, and storage battery operation cents per watt-hour, operation from the light line costs only cents per kilowatt-hour!

Low voltage for instrument operation is commonly and effectively secured by use of a step-down transformer, the primary voltage being that of the line, the secondary voltage that called for by the instrument. Although "doorbell" transformers can be used for this purpose, provided the current drain is low and voltage regulation is not critical, best operation will be secured by use of standard "filament type" transformers, which come in a wide variety of voltages and current ratings. Any standard brand, such as "Stancor,"[3] can be used with assurance. In general, the small open frame transformers will be satisfactory for indoor meteorological use, and purchase of the more

[2] Cataldo, J. T. (Editor), *International Rectifier Corporation Engineering Handbook*, International Rectifier Corp. El Segundo, Calif. Current Edition, $1.50. postpaid.

[3] Made by Chicago Standard Transformer Co., 3501 West Addison St. Chicago 18, Ill. Several competing brands, having about the same formats, specifications, and prices, will perform about as well. A number of "off brand" and "surplus" transformers, purporting to have "standard" characteristics, and selling at very low prices, may or may not be bargains. *Caveat emptor.*

costly "Mil. Spec." and "Hermetically Sealed" transformers is neither necessary nor economically desirable. Connections of a small step-down transformer are shown in Fig. 1, D.

Where the instrument supply voltage must be held within narrow limits, or where the supply line voltage has manic-depressive characteristics, as at many military installations and airports, the effects of line voltage variations can be greatly reduced by use of a constant-voltage step-down transformer, such as a *Sola*.[4] This type of transformer gives an output voltage constant within one percent or better when the input voltage varies fifteen percent or more.

Direct current instruments can be operated from the light line by use of a step-down transformer and a rectifier, as in Fig. 1, E. The combination shown uses a bridge rectifier, and gives an output of direct current which is interrupted at twice the line frequency. Thus, in most locations, the rate of interruptions, or "ripple," is 120 cycles, line frequency being 60 cycles. Although this full-wave-rectified output can be used directly on many instruments, or for charging batteries, better performance is secured if the ripple is reduced. This is commonly done by shunting a large capacitor across the rectifier output, as in Fig. 2, F. Capacitance required will depend upon load, but 2,000 microfarads is suitable for most six volt circuits if the load is less than two amperes.

Another useful method of ripple reduction is to "float" a battery across the rectifier output, as in Fig. 2, G. With this connection, the rectifier output voltage should be slightly higher than the rated battery voltage. The battery remains fully charged at all times, and absorbs a large part of the ripple formerly present in the rectifier output. This circuit has another interesting and useful property. If the A.C. power fails, equipment connected to the output keeps right on working, drawing power from the battery until the A.C. power resumes, at which time the battery is recharged, and the equipment again operated from the rectified and filtered A.C. This is almost identical to the "trickle charger" circuit used on home radios three decades ago.

Although the battery customarily used here is a storage battery, a heavy-duty dry cell can also be used successfully. In this circuit, a six-volt "Hot Shot" battery (four number six dry cells wired in series and cased together) will last more than two years.

Rectifier types available for this circuit are copper oxide, selenium, and silicon. At present (January, 1960), selenium rectifiers are cheapest, but have a limited service life (2–4 years); while silicon rectifiers, costing slightly more in most ratings, seem to be well-nigh immortal.

---

[4] Made by Sola Electric Co., Chicago 50, Ill.

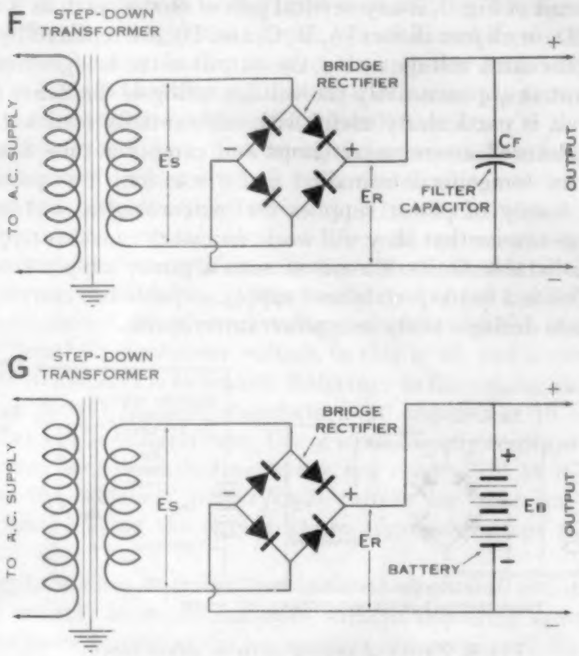


FIG. 2. Methods of ripple reduction.

Data for selecting rectifiers for this use are contained in manufacturers' manuals.[5]

Recent experimentation with Zener diodes shows that they can be employed in a bridge circuit to produce a constant-output rectifier.

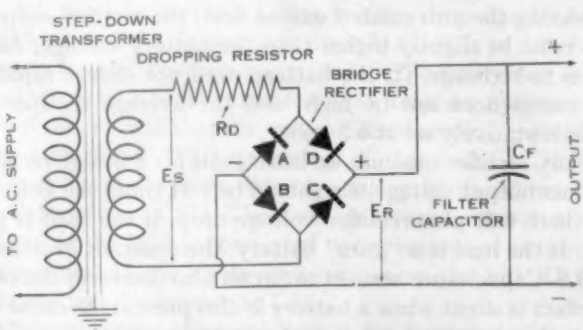


FIG. 3. Constant-output bridge rectifier.

[5] *Federal's Selenium Rectifier Handbook*, Federal Telephone and Radio Co., 100 Kingsland Road, Clifton, N. J. Current Edition, 50 cents. *Silicon Rectifier Handbook*, Sarkes Tarzian, Inc. 415 N. College Ave., Bloomington, Indiana, Current Edition. $1.00.

In the circuit of Fig. 3, if any vertical pair of diodes, such as A and B, or C and D, or all four diodes (A, B, C, and D), are replaced by Zener diodes of the same voltage rating, the output of the bridge circuit will be constant at approximately the voltage rating of the Zener diodes. This circuit is particularly useful with substantially constant loads, such as photocell anemometer lamps and computer tube filaments.

From the foregoing information and discussion, it is possible to design a family of power supplies for meteorological instruments, with the assurance that they will work, and work consistently, within easily predictable limits. Circuit of such a power supply comprises Fig. 4. This is a battery-stabilized supply, capable of "carrying" the instruments during a fairly long power interruption.

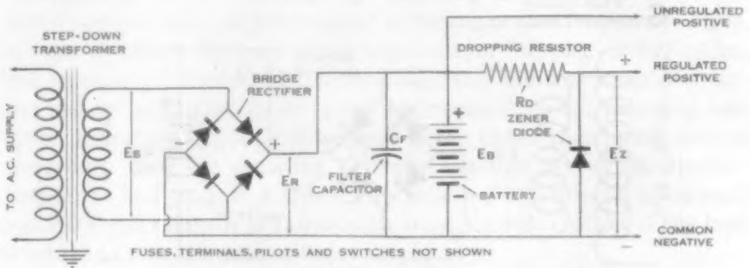


FIG. 4. Circuit of general-purpose power supply.

To simplify design discussion, we will set the supply voltage at 110 volts, 60 cycles; the battery voltage at 6.3, which will also be the unregulated output voltage; and the regulated output at 4.7 volts, with a maximum current drain of 0.25 amperes. Average drain at the unregulated voltage will be set at 5.0 amperes.

Considering the unregulated output first, the rectifier output voltage, *Er*, must be slightly higher than the battery voltage, *Eb*, if the battery is to recharge. As the battery need not charge rapidly, this voltage excess need not be high, and the average rectifier output voltage is tentatively set at 6.5 volts.

From any rectifier manual, we learn that, for a bridge rectifier, the transformer output voltage, *Es*, should be 1.11 times the D.C. voltage desired (here 6.5) plus rectifier voltage drop, if the load is pure resistance. If the load is a "pure" battery, the constant decreases from 1.11 to 0.8. Capacitance across the circuit also decreases the constant, but its effect is slight when a battery is also present. Because the current into the resistive load (i.e. the instruments) will usually considerably exceed the current needed to keep the battery charged, we can set the constant at approximately 1, so that the transformer secondary voltage should be 6.5 plus the rectifier drop.

Choice of rectifiers is next. Total load will be the five amperes specified for the unregulated output, plus 0.25 amperes at the regulated output, plus a smaller current through the Zener diode, plus current to keep the battery at full charge. Allowing a generous margin of safety, a 10-ampere bridge rectifier is indicated here.

Using silicon rectifiers, because of their convenience, long service life, low voltage drop, and small bulk, this need can be met with a bridge of four, using Sarkes-Tarzian type 10-LF rectifiers, or equivalent. These have a voltage drop of 1.5 each, approximately, at full load. As there are two rectifiers in series with the load at all times in a bridge circuit, rectifier drop is approximately 3 at full load.

In consequence, transformer voltage must be 6.5+3, or 9.5. The nearest "stock" transformer voltage to this is 10, and a current capacity of 10 amperes is indicated. Reference to the catalog shows that a Stancor P-6461 filament transformer (10 amperes at 10 volts), or equivalent will be suitable here. Use of a more costly constant-voltage transformer here is neither necessary nor economical at most locations, as the "floated" battery will correct for most line voltage fluctuations, holding the output at the terminal voltage (6.3) very closely.

Value of the filter capacitor here is not at all critical, and it may be omitted entirely in many instances without impairing operation of either the power supply or the instruments connected to it. An electrolytic capacitor of about 500 microfarads, with a voltage rating of about 25, is all that is needed here, even with highly "hum sensitive" instruments.

Remaining to be determined are the constants of the regulated output circuit. Voltage is 4.7, previously set arbitrarily, and held constant by a 4.7 volt Zener diode (standard value). The dropping resistor, *Rd*, must be so chosen that voltage drop due to both the regulated load and the Zener diode drain is 6.3–4.7, or 1.6. Allowing 0.08 ampere for the Zener current, and 0.25 ampere for the regulated load, gives us a total current of 0.33 ampere. Applying Ohm's Law ($R=E/I$), we find that the value of the dropping resistor should be about 4.85 ohms. Wattage rating of this resistor ($W=EI$) is 1.6×0.33, or about .53 watt. Wattage rating of the Zener diode is similarly determined as .375. These values are true, correct, and useful only as long as the load is connected to the regulated output. If the load is disconnected, the Zener diode will carry the full .33 ampere, raising its wattage dissipation to 1.55.

An additional source of overcurrent in the regulated circuit should be guarded against here. If, by any mischance, the unregulated load and the battery are both disconnected from the supply, voltage across the filter capacitor will rise greatly, voltage drop in the rectifier sys-

tem will decrease greatly, and voltage applied to the regulated circuit will approach (but not reach) the peak voltage of the transformer secondary, which is $10\sqrt{2}$, or approximately 15.

Under these conditions, voltage across the dropping resistor will approach 10, and current through both it and the Zener diode will approach 2 amperes. If the Zener diode burns out from this current, there will be no more voltage regulation, and a very high voltage (up to perhaps 15) will be applied to the regulated load, probably damaging it severely.

This unhappy eventuality can be guarded against by placing a suitable fuse (such as $\frac{1}{2}$ ampere) between the battery and the dropping resistor, or better by using dropping resistor and Zener diode of sufficient wattage rating to stand the overvoltage. In this instance, a 20-watt five ohm (standard stock value), and a 10-watt 4.7 volt Zener diode will be adequate. With these values, no change in load or batbery connections can damage any part of the circuit.

Battery to "float" in this type of supply can be anything from a 6-volt "hot shot" (such as a Burgess S-461) to a 500 ampere hour "Submarine" storage battery. The dry cell has a service life here of not more than two years, and is able to "carry" a five ampere load for somewhat more than thirty minutes two or three times during this interval. More suitable is an 80 ampere hour automotive storage battery, which has a rated life of at least two years, and which is capable of "carrying" a five ampere load during a power interruption exceeding twelve hours. After recharge, this battery is ready to repeat the performance, ultimate life exceeding 1,000 charge-discharge cycles. Use of a battery of much greater ampere-hour capacity is seldom economically justified.

From the information outlined and cited above, it should be possible to design a power supply capable of carrying the current loads of any small or medium-sized meteorological instrument installation, using only standard components, available "over the counter" at almost any electronic parts distributor's. Choice of auxiliary devices, such as fuses, switches, pilot lights, etc. is determined by the needs of the particular installation, and the requirements of the local electrical code, which should be complied with insofar as possible.

DEVICE TO HEAT OR COOL

A tiny new thermoelectric device that can boil or freeze a drop of water using the power from two flashlight batteries has been developed by Hughes Aircraft Company. The device, which is smaller than a paper clip, heats at the junction of two special semiconductor materials when a current is passed through it. It cools when the direction of the current flow is reversed by flipping a switch. In clusters, its uses could range from maintaining room temperature in a space ship to operating an instant-defrosting refrigerator with no moving parts.

Problem Department

Conducted by Margaret F. Willerding

San Diego State College, San Diego, Calif.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problem should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the Department desires to serve her readers by making it interesting and helpful to them. Address suggestions and problems to Margaret F. Willerding, San Diego State College, San Diego, Calif.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solution should observe the following instructions.

1. Solutions should be in typed form, double spaced.

2. Drawings in India ink should be on a separate page from the solution.

3. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

4. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

2763, 2764, 2766. *T. R. Curry, Oyster Bay, N.Y.*

2761. *John Kinloch, Nashville, Tenn.*

2755, 2760, 2766. *C. W. Trigg, Los Angeles, Calif.*

2765. *Brother Alfred, St. Mary's, Calif.*

2761, 2764. *J. Byers King, Denton, Md.*

2767. *Proposed by Walter H. Carnahan, Madison, Wis.*

Find the smallest pair of consecutive odd integers each of which is the difference of two cube integers.

Solution by Brother Felix John, Philadelphia, Pa.

$$5^3-4^3=61 \quad \text{and} \quad 4^3-1^3=63.$$

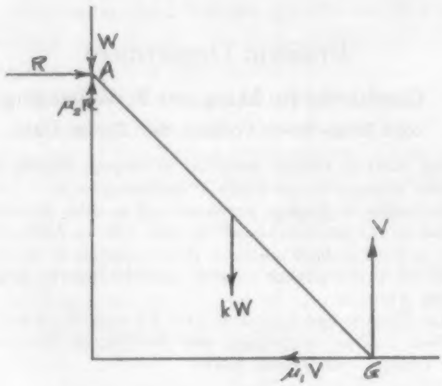
Another pair, not the smallest, are:

$$6^3-1^3=215 \quad \text{and} \quad 9^3-8^3=217.$$

Solutions were also offered by Donald R. Byrkit, West Chicago, Ill.; George Cunningham, Concord, N. H.; J. A. H. Hunter, Toronto, Canada; Sarane Loeb, Chicago, Ill.; and C. W. Trigg, Los Angeles, Calif.

2768. *Proposed by C. W. Trigg, Los Angeles City College*

A uniform ladder rests against a vertical wall, to which it is inclined at an angle of 45°. The coefficients of friction of the wall and of the ground are respectively $\frac{1}{3}$ and $\frac{1}{2}$. A man climbs up the ladder and just gets to the top as the ladder starts to slip. What are the relative weights of the man and the ladder?



Solution by the Proposer

Let the weights of the man and the ladder be W and kW, respectively. Then from the figure:

Vertical components:

$$V+\mu_2 R=kW+W \tag{1}$$

Horizontal components:

$$R=\mu_1 V \tag{2}$$

Moments about A:

$$\tfrac{1}{2}kW+\mu_1 V=V \tag{3}$$

From (1) and (2):

$$V(1+\mu_1\mu_2)=W(k+1) \tag{4}$$

From (3) and (4):

$$\frac{V}{W}=\frac{k+1}{1+\mu_1\mu_2}=\frac{\frac{1}{2}k}{1-\mu_1}\,.$$

Hence

$$k=2(1-\mu_1)/(2\mu_1+\mu_1\mu_2-1).$$

In this problem, $\mu_1=\frac{1}{2}$ and $\mu_2=\frac{1}{3}$, so $k=6$. That is, the ladder weighs 6 times the man's weight.

A solution was also offered by William K. Viertel, Canton, N. Y.

2769. *Proposed by Brother Felix John, Philadelphia, Pa.*

Determine a formula for the sum of the products of every pair of the squares of the first n whole numbers.

Solution by Herbert R. Leifer, Pittsburgh, Pa.

The sum of the products of every pair of the squares of the first n whole numbers will be represented by $\sum x_i^2 x_j^2$.

$$\left(\sum_{x=1}^{n} x^2\right)^2=\sum_{x=1}^{n} x^4+2\sum_{x} x_i^2 x_j^2.$$

$$\sum x_i^2 x_j^2=\left[\left(\sum_{x=1}^{n} x^2\right)^2-\sum_{x=1}^{n} x^4\right]/2.$$

Since

$$\sum_{x=1}^{n} x^2 = n(n+1)(2n+1)/6$$

and

$$\sum_{x=1}^{n} x^4 = (6n^5+15n^4+10n^3-n)/30,$$

$$\sum x_i^2 x_j^2 = [n^2(n+1)^2(2n+1)^2/36-(6n^5+15n^4+10n^3-n)/30]/2$$
$$= n(n^2-1)(4n^2-1)(5n+6)/360.$$

Solutions were also offered by C. W. Trigg, Los Angeles, Calif.; Herbert Wolf, Chicago, Ill.; and the proposer.

2770. *No solution has been offered.*

2771. *Proposed by Barry Kolb, Chicago, Ill.*

Prove in any triangle ABC,

$$(a+b-c)/2c = \lim_{n\to\infty} \sum_{k=1}^{n} (\tan \tfrac{1}{2}A \tan \tfrac{1}{2}B)^k.$$

Solution by C. W. Trigg, Los Angeles City College

In any triangle,

$$\tan \tfrac{1}{2}A \tan \tfrac{1}{2}B = \frac{r}{s-a}\cdot\frac{r}{s-b} = \frac{(s-a)(s-b)(s-c)/s}{(s-a)(s-b)} = \frac{s-c}{s}.$$

Thus the right-hand member of the proposed relation is the sum to infinity of a geometric series in which both the first term and the common ratio equal $(s-c)/s$. Hence

$$\lim_{n\to\infty} \sum_{k=1}^{n} (\tan \tfrac{1}{2}A \tan \tfrac{1}{2}B)^k = \frac{(s-c)/s}{1-(s-c)/s} = \frac{s-c}{c} = \frac{\tfrac{1}{2}(a+b+c)-c}{c} = (a+b-c)/2c.$$

A solution was also offered by the proposer.

2772. *Taken from "More Problematical Recreations."*

Using only mathematical signs and without changing the position of any of the figures, can you make this into an equation?

$$2967 = 17.$$

Solution by C. W. Trigg, Los Angeles City College

This is the January 17 item in R. M. Lucey's *A Problem a Day* (Penguin Books, 1952) where a solution, $\sqrt{296-7} = 17$ is given.

The following additional solutions are given by C. W. Trigg in *Mathematics Magazine*, 34, 163, January–February 1961:

$$(2)(9)+6-7=17,$$
$$-2+9-6+7=1+7, \qquad [2+(9)(6)]/7=1+7,$$
$$2-9+6+7=-1+7, \qquad -2+9+6-7=-1+7,$$
$$(-2+9-6)(7)=1(7), \qquad (2-9)(6-7)=1(7), \qquad (-2+9)(-6+7)=1(7),$$
$$(-2+9-6)/7=1/7, \qquad (-2-\sqrt{9}+6)/7=1/7,$$

and the equations which result from obvious changes of signs which will make both sides of the above equations negative.

Other solutions are

$$!2+\sqrt{9}+6+7=17, \quad 2+!(\sqrt{9})+6+7=17, \quad !2+!(-!\sqrt{9}+6)+7=17,$$

$$2\sqrt{9}/6+7=1+7, \quad 2-(\sqrt{9}!)/6+7=1+7, \quad !2+\sqrt{9}!-6+7=1+7$$

$$2\sqrt{9}(-6+7)=-1+7,$$

$$2\sqrt{9}-6+7=1(7), \quad (2\sqrt{9}/6)(7)=1(7), \quad [2-(\sqrt{9}!)/6](7)=1(7)$$

where subfactorial $2=!2=1$, $!3=2$, and $!4=9$.

Solutions in the duodecimal scale of notation are

$$(2)(9)-6+7=17 \quad \text{and} \quad 2\sqrt{9}+6+7=17.$$

Solutions were also offered by Donald Byrkit, West Chicago, Ill.; Felix John, Philadelphia, Pa.; Sarane Loeb, Chicago, Ill.; and Warren Rufus Smith, Brooklyn, N.Y.

STUDENT HONOR ROLL

The Editor will be very happy to make special mention of classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each student contributor will receive a copy of the magazine in which his name appears.

The Student Honor Roll for this issue appears below.

2765. *Linda Feinman, Brooklyn, N. Y.*

2772. *Judith Goszewski, Bernadette Dryjan, Patricia Brennan, Melanie Renk, Patricia Brown, Mary Pat Brown, all of Visitation High School, Chicago, Ill.*

2772. *Lawrence Keeley, Eldred Central School, Eldred, N. Y.*

2737, 2739, 2740, 2772. *Martin Hoffman, Boston Latin School, Boston, Mass.*

2772. *Sharon Husted, Lodi, Calif.*

2761. *Robert Smith, North Caroline High School, Denton, Md.*

2756. *Jean Scudder, North Caroline High School, Denton, Md.*

2764. *Janice Olcavary, Trumbull, Conn.*

2772. *Donald Nelson, Allegheny High School, Pittsburgh, Pa.*

PROBLEMS FOR SOLUTION

2791. *Proposed by Cecil B. Read, University of Wichita, Wichita, Kans.*

Show that the fraction

$$\frac{1234567}{3456789}$$

may be approximated by 12/35 with an error less than 0.05.

2792. *Proposed by C. W. Trigg, Los Angeles City College.*

Show that is $a=e^{2\pi i/5}$, then

$$(x^5-y^5)/(x-y)=(ax-y)(a^2x-y)(a^3x-y)(a^4x-y)$$

and

$$(x^5+y^5)/(x+y)=(ax+y)(a^2x+y)(a^3x+y)(a^4x+y).$$

2793. *Proposed by William K. Viertel, Canton, N. Y.*

In grinding a mirror for a reflecting telescope, a Pyrex glass "blank" is rubbed

with another glass disc of equal diameter (called the "tool"), using grinding compounds of progressively smaller mesh, until the blank is hollowed out to approximately spherical shape and of the correct depth for the size mirror and the desired focal length. Finally, the spherical shape is changed to parabolic shape by selective grinding where testing shows it is needed. After final testing by optical methods, the finished mirror is ready for aluminizing and use in a telescope.

Problem: to find the difference between true spherical and true parabolic shapes at a distance of 3 in. from the center of a 12 lin. diameter mirror of 48 in. focal length.

2794. *Proposed by Brother Felix John, Philadelphia, Pa.*

The sides of a triangle are in arithmetic progression having a common difference of one. If the area of the triangle is 84 square units, find the three sides.

2795. *Proposed by Enoch J. Haga, Turlock, Calif.*

In a recent issue of a national magazine there appeared a contest. The contest consisted of estimating the amount of money shown in a picture. In the picture, on the top of a stagecoach, were visible;

1) on the seat: 2 locked chests and 4 bags;
2) on the roof: 9 bags, 4 open chests, 2 suitcases, 1 traveling bag, and 2 barrels.

The instructions stated that each bag contained a thousand silver dollars, and that each chest contained an equal number of currently circulating silver coins. The instructions closed with an equation, essentially this:

Let x = silver dollars in roof
y = coins in chests.
Then $y=2x$.

How many coins of each kind were there? What was their total amount in dollars?

2796. *Proposed by J. W. Lindsey, Amarillo, Texas.*

Solve $2x^3-7x^2+10x-6=0$.

Books and Teaching Aids Received

BIOLOGY

High School Biology. For Experimental Use During the School Year 1960-61, by the Biological Sciences Curriculum Study, American Institute of Biological Sciences, University of Colorado, Boulder, Colorado. All paper. All 19×26. The study includes the following books:

Teacher's Commentary (All text versions) Part one.
Biological Invesgiations for Secondary School Students. 402 pages.
Interdependence of Structure and Function (A laboratory block on) 137 pages.
A laboratory block on Animal Growth and Development. 163 pages.
A laboratory block on Microbes: Their Growth, Nutrition and Interaction. 189 pages.

Yellow Version includes the following:

Part One.
Part Two.
The laboratory Teacher's guide. Part one.
The laboratory Teacher's guide. Part two.
The laboratory. Part one.
The laboratory. Part two.

Blue Version includes the following:

The laboratory. Part one.
The laboratory. Part two.
The laboratory. Teachers' guide. Part one.
The laboratory. Part three.
The laboratory. Teachers' guide. Part two.
The laboratory. Teachers' guide. Part three.
Text. Part one.
Text. Part two.
Text. Part three.

Green Version includes the following:

Text. Part one.
Text. Part two.
The laboratory Teachers' guide. Part one.
The laboratory Teachers' guide. Part two.
The laboratory. Part one.
The laboratory. Part two.

VIRUSES AND THE NATURE OF LIFE, by Wendell M. Stanley and Evans G. Valens. Cloth. 15×22 cm. 224 pages. 1961. E. P. Dutton & Company, 300 Park Ave., New York 10, N. Y. Price $4.95.

GLOSSARY OF GENETICS AND OTHER BIOLOGICAL TERMS, by Russell B. Clapper. Cloth. 12.5×19 cm. 200 pages. Vantage Press, Inc., 120 W. 31 St., New York 1, N. Y. Price $3.95.

THE AMAZING WORLD OF MEDICINE, by Helen Wright and Samuel Rapport. Cloth. 13.5×19.5 cm. Pages x+301. 1961. Harper & Brothers Publishers, 49 East 33rd St., New York 16, N. Y. Price $3.50.

CELLULAR PHYSIOLOGY AND BIOCHEMISTRY, by William D. McElroy. Paper, 14.5×21 cm. Pages viii+120. 1961. Prentice-Hall, Inc., Englewood Cliffs. N. J. Price $1.50.

PHYSICS

THE ATOM AND ITS NUCLEUS, by George Gamow. Paper. 13×19.5 cm. 154 pages. 1961. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. Price $1.95.

CHEMISTRY

CHEMISTRY, by Leonard J. Fliedner and Louis Teichman. Cloth. 15×22 cm. Pages ix+625. 1961. Allyn and Bacon, Tremont Street, Boston, Massachusetts.

ORGANIC CHEMISTRY, by Keith M. Seymour, *Butler University*. Cloth. 14.5×21 cm. Pages xiii+317. 1961. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. Price $9.00.

LABORATORY MANUAL FOR CHEMISTRY—MAN'S SERVANT, by Leonard J. Fliedner and Louis Teichman. Paper. 19×26 cm. Pages xii+225. 1961. Allyn & Bacon, Tremont St., Boston, Mass.

TESTS FOR CHEMISTRY—MAN'S SERVANT. Paper. 75 pages. 19×26 cm.

MATHEMATICS

A NEW ANALYTIC GEOMTRY, by Durrant, Kingston, Sharp, and Kerr. Cloth. 13×17.5 cm. Pages ix+362. 1961. St. Martin's Press, 175 Fifth Ave., New York 10, N. Y.

FINITE DIFFERENCE EQUATIONS, by H. Levy and F. Lessman. Cloth. 13.5×19 cm. Pages vi+278. 1961. Macmillan Company, 60 Fifth Ave., New York 11, N. Y. Price $5.50.

LINEAR ALGEBRA, by Kennth Hoffman and Ray Kunze. Cloth. 14.5×21 cm. Pages ix+332. 1961. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. Trade Edition $10.00. Text Edition for classroom adoption $7.50.

ADVANCED ALGEBRA, by Myron R. White. Cloth. 14×21.5 cm. Pages x+382. 1961. Allyn and Bacon, Tremont Street, Boston, Massachusetts.

REFRESHER ARITHMETIC, by Edwin I. Stein. Cloth. 14×22 cm. Pages xiv+462. 1961. Allyn and Bacon, Tremont Street, Boston, Massachusetts.

ANALYTIC GEOMETRY WITH CALCULUS, by Robert C. Yates. Cloth. 14.5×21 cm. Pages xi+247. Price $5.95. Prentice-Hall Inc., Tremont St., Boston, Mass.

MISCELLANEOUS

THE RADIO AMATEUR'S HANDBOOK, by the Headquarters Staff of the American Radio Relay League. Paper. 15×22 cm. 724 pages. 1961. American Radio Relay League, Administrative Headquarters, West Hartford 7, Conn. Price $3.50.

TEXTBOOK OF ALGEBRA, Vol. I and II, by G. Chrystal, *M.A., LL.D., University of Edinburgh*. Both cloth. Both 12.5×18.5 cm. Vol. I pages xxiv+571. Vol. II pages xxiii+616. 1961. Chelsea Publishing Company, 50 E. Fordham Rd., New York 68, N. Y. Price $2.95 per volume.

WATCH THE TIDES, by David Greenhood. Cloth. 18×17 cm. 37 pages. 1961. Holiday House, 8 West 13th Street, New York 11, N. Y. Price $2.75.

X-15 DIARY, by Richard Tregaskis. Cloth. 13.5×19 cm. 317 pages. 1961. E. P. Dutton & Company, 300 Park Ave., New York 10, N. Y. Price $4.95.

NATIONAL DEFENSE COUNSELING AND GUIDANCE TRAINING INSTITUTES. Paper. 14.5×21 cm. 15 pages. U. S. Department of Health, Education, and Welfare, Office of Education, Washington, D. C.

NATIONAL DEFENSE LANGUAGE INSTITUTES PROGRAM. Announcement Summer 1961 and Academic Year 1961–62. Paper. 14.5×21 cm. 14 pages. U. S. Department of Health, Education, and Welfare, Office of Education, Washington, D. C.

GUIDANCE FOR THE ACADEMICALLY TALENTED STUDENT. Paper. 14×21 cm. 144 pages. 1961. American Personnel and Guidance Association, 1605 New Hampshire Ave., NW, Washington 9, D. C.

SOCIAL FORCES INFLUENCING AMERICAN EDUCATION, edited by Nelson B. Henry. Paper. 14×21 cm. Pages 252+xcv. 1961. The University of Chicago Press, Chicago 37, Illinois.

OFFERINGS AND ENROLLMENTS IN SCIENCE AND MATHEMATICS IN PUBLIC HIGH SCHOOL. Paper. 14×21 cm. 87 pages. U. S. Department of Health, Education, and Welfare, Office of Education, Washington, D. C.

LETTERS TO MY TEACHER, by Dagobert D. Runes. Cloth. 13.5×10.5 cm. Pages 105. 1961. Philosophical Library, Inc., 15 East 40th St., New York 16, N. Y. Price $2.75.

THE INDIVIDUAL AND THE UNIVERSE, by A. C. B. Lovell. Paper. 10×16.5 cm. 126 pages. 1961. The New American Library of World Literature, Inc., 501 Madison Ave., New York 22, N. Y. Price $.50.

Book Reviews

THE INTERNATIONAL DICTIONARY OF APPLIED MATHEMATICS. Cloth. 25×17 cm. 1173 pages. 1960. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J. Price $25.00.

This reference work of more than a thousand large sized pages purports to define terms and describe methods in a wide range of applications of mathematics. Both the level of mathematical maturity, and the depth of coverage, vary widely. For example, one finds such terms as *improper fraction* and *abscissa* on the one hand, and *eigenfunction* and *parexic analysis* at the other (it is not implied that these are necessarily the extremes). The treatment varies from a few lines to several pages, as for example S-Matrix (over 7 pages); Heat Transfer (4 pages); Harmonic Function (about ½ page). There are a very large number of cross references, which aid appreciably in finding a topic. In a random sampling of topics, the reviewer found no place where he thought the treatment incorrect, although his personal opinion as to the space which should be allotted topics did not always agree with that actually used.

Probably no two people would agree as to what should be covered, or the extent of coverage, in a reference work of this type. There is no mention, for example, of integro-differential equations, or of eccentric angle (to mention a couple of essentially trivial illustrations). On the other hand, the reviewer knows of no work which even remotely approaches the coverage found in this work. Four indices, giving the English equivalent of German, Russian, French, and Spanish mathematical terms, should prove invaluable.

Certainly this work should be in every university library. Whether or not the high school library can afford the cost would depend upon the size of the budget—the book will find relatively little use at this level. The typography is excellent, terms displayed are well displayed, and at no place does the material seem crowded.

CECIL B. READ
University of Wichita

OPTICS OF THE ELECTROMAGNETIC SPECTRUM, by C. L. Andrews, *State University of New York*. Cloth. x+501 pages. 23×14.5 cm. 1960. Prentice-Hall, Inc., Englewood Cliffs, N. J. Trade Edition $12.00; Classroom Edition $9.00.

In this textbook the author has attempted to treat the entire electromagnetic spectrum with special emphasis on recent developments in the field. Use is made of experiments with microwaves to illustrate properties of electromagnetic waves in general. In most cases these experiments are written in sufficient detail so that the reader may perform and make use of them, particularly for demonstration purposes.

The book begins with a brief discussion of the entire electromagnetic spectrum. Then, detailed treatment is given to propagation, superposition, velocity, interference, diffraction, electromagnetic theory, absorption, dispersion, and polarization of waves of the electromagnetic spectrum. Appendix I and II include differential equation of longitudinal waves, and derivation of Kirchhoff's formulation of Fresnel's theory of diffraction, respectively. Tables of Fresnel integrals and Bessel integrals are included as well as answers to alternate problems.

The textbook is well illustrated and easily followed. Large diagrams are used frequently.

No previous course in electromagnetic theory is necessary for an understanding of the material presented. A student with a background in general college physics and elementary calculus should find the books interesting and easy to follow. Hence, the textbook should be found useful in the first course in electromagnetic theory beyond these two courses.

It is the opinion of this reviewer that this is a well written and interesting book.

J. BRYCE LOCKWOOD
Highland Park Junior College
Highland Park, Mich.

FOUNDATIONS OF GEOMETRY AND TRIGONOMETRY, by Howard Levi. Cloth. 14.5×23 cm. 347 pages. 1960. Prentice-Hall, Englewood Cliffs, New Jersey. Price $7.95.

This book consists of two parts: one is a formal axiomatic development of affine and Euclidean geometry and trigonometry based on the real number system; paralleling this formal discussion are comments, illustrations and examples which explain to the reader the significance of the basic theory. In the second part are included such things as the consequences of making a different assumption as in the case of the parallel axiom where some attention is given to the existence of non-Euclidean geometries.

The careful definition of many terms found in modern writing in geometry is helpful. These include such terms as coordinate system, distance system, affinity, affine plane, point reflection, line reflection, isometry and area as a real number. The language of sets is maintained throughout the book. Care has been used in the introduction of coordinates both on a line and in the plane with attention given to properties which are independent of the system used. The development of properties of a straight line, the affine plane and the Euclidean plane seem to move along smoothly but the sections on angle measurement and area seem a bit tedious with some proofs omitted. The material covered falls short of the usual content of analytic geometry with attention concentrated on line and circles.

Quoting from the preface, "The book is intended to be a text for a course which is not now generally given in the United States. It presupposes the equivalent of a sound high school course in algebra, including some familiarity with set language, equations, and the real number system. It requires no formal knowledge of geometry, but some acquaintance with intuitive geometry is highly desirable." The reviewer considers this an excellent book for teachers or others who are interested in an axiomatic development based on the number system but does not see an immediate place for it as a textbook in either high school or college.

FERNA E. WRESTLER
University of Wichita
Wichita, Kansas

RELATIONSHIP OF CANCER TO ENVIRONMENT STUDIED

The rate of cancer occurrence may be related to man's environment. Cancer seems to occur more often in populated regions where radiation is much higher than normal due to radioactive rocks.

In survey of radioactivity by Government geologists in Washington County, Md., distinct differences in the radioactivity of rock masses were found. Some rocks were ten times more radioactive than others in the county. Although the number of higher radiation readings was relatively small, the higher readings seemed to be in populated areas where the cancer rate was higher than normal.

The radioactivity survey is part of a program initiated by the National Cancer Institute here to see if the geographic distribution of cancer in the county is related to various factors in man's surroundings. The program, conducted in cooperation with the Washington County Health Department, includes both checking available information on the county's present population, and analyzing the vegetation, soils and rocks in the county.

Before the scientific sutdies were begun, old population records were checked for accuracy and the death rate from cancer. The population was grouped according to election districts, because these were the smallest geographical units for which accurate records had been kept. Preliminary results show that certain districts definitely had a higher rate of cancer than others.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS, INC.

APPLICATION FOR MEMBERSHIP

Date .... 19......

I hereby apply for membership in the Central Association of Science and Mathematics Teachers, Inc., and enclose $5.00 for annual membership dues, which includes one year's subscription to SCHOOL SCIENCE AND MATHEMATICS. I will receive nine issues of this journal, none being published in July, August or September. (Subscriptions beginning with January issue expire with December; with October issue expire with June.)

Begin: JANUARY ☐ Begin: OCTOBER ☐

(PLEASE PRINT)

Name ....
Last Name First Name

School Address ....
Name of School City State

Home Address ....
Street City Postal Zone State

Journals will be sent to home address unless otherwise requested

Underline Section in which enrollment is desired: *Biology, Chemistry, Elementary Science, Elementary Mathematics, General Science, Geography, Mathematics, Physics* ....

Mail this application with $5.00 (Canada $5.00, Foreign $5.50) to Central Association of Science and Mathematics Teachers, Inc., P.O. Box 108, Bluffton, Ohio.

PLEASE CHECK IF YOU FORMERLY WERE A MEMBER ☐